Sewer Master Plan

APPENDICES

APPENDIX A

EXISTING AND FUTURE LAND USE ESTIMATE TM

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject:	Existing and Future Land Use Estimates
Prepared For:	Jorge Bermudez
Prepared By:	Helene Kubler
Reviewed By:	Curtis Lam; Justine Faisst; Tom Richardson
CC:	Darryl Wong, Marilyn Nickel, Steve Burkey, Marina Rush
Date:	October 2001 (DRAFT) December 2002 (FINAL)

The identification of the most appropriate land use database and the evaluation of the existing land use and future land use scenarios are critical tasks when embarking on the water and sewer master planning process. It is the key to develop future water demands and existing and future wastewater flows, which will be used to develop the water and wastewater system computer model. The model will be the basis for estimating necessary water and wastewater system improvements and developing a capital improvement program.

This memorandum provides a summary of the existing and future land use estimates for the City of Milpitas study area that will be used for development of the Water and Sewer Master Plan.

This TM is organized as follows:

Introduction
Land Use Database
Existing Land Use
Future Land Use

Note: Maps of the identified existing and future land use can be found at the end of the TM.

References:

Milpitas Midtown Specific Plan, Draft (EDAW, August 2001)
Conceptual Plan Alternatives, Milpitas Midtown Specific Plan (EDAW, July 2000)
Milpitas Midtown Specific Plan, Existing Conditions (EDAW, April 2000)
City of Milpitas Ortho-photo (City of Milpitas, July 1999)
Resolution No. 6796 of the City Council of the City of Milpitas (City of Milpitas, December 1999)
City of Milpitas General Plan (City of Milpitas, December 1994, Amended June 1998)
City of Milpitas Water Master Plan Update (John Carollo Engineers, June 1994)
City of Milpitas Sewer Master Plan Update (John Carollo Engineers, June 1994)

Introduction

For the purpose of the Water and Sewer Master Plan, the study area consists of the outermost extent of the City urban service area. The urban service area boundary was defined based on the General Plan and General Plan amendments, including Resolution No. 6796 of the City Council. This 1998 resolution established a new urban service area boundary by prohibiting City services in areas outside of the urban growth boundary and outside of the City limits. This resolution is applicable until December 2018. It can be amended under specific circumstances that are described in Resolution No. 6796 of the City Council. Such an amendment would require a General Plan amendment. For the purpose of the Water and Sewer Master Plan, it is assumed that the resolution will not be amended before 2018. Map 1 shows the City limits, urban growth boundary and study area.

Important land use changes have occurred in Milpitas since the 1994 Master Plan Update. Significant commercial and office growth occurred, particularly in the western areas of Milpitas, with the completion of McCarthy Ranch in 1997 and Cisco System campus in 2000. A number of residential areas were also developed, including the Parc Metropolitan Housing and Monte-Vista Apartments multi-family high-density communities near the Great Mall. Open spaces were converted from agricultural uses to domestic and irrigation type uses. Current key land use issues are threefold:

- Vacant Land Development in the Valley Floor Area
- Vacant Land Development in the Hillside Area
- Redevelopment in the Valley Floor Area

An approximate 17-year planning horizon was assumed for the Water and Sewer Master Plan to fit within the timeframe of the 1998 resolution. The identification of the necessary distribution and collection system improvements associated with this planning horizon will require evaluating the existing land use (as of June 2001) and the long-term land use scenario (as of 2018). The prioritization of these improvements, essential to the development of the capital improvement program (CIP), will require estimating the phasing of development and redevelopment between 2001-2018. In addition, the City specifically required the development of a near- and long-term CIP. The near-term CIP shall consist of a 5-year CIP, covering fiscal years 2002/2003 through 2007/2008. The level of development and redevelopment anticipated to occur by 2008 will therefore be emphasized. A near-term land use scenario as of 2008 will be considered.

Finally, the following items will be evaluated as part of the Master Plan:

- Existing land use (as of June 2001);
- Development and redevelopment phasing between 2001-2018;
- Near-term land use (year 2008); and,
- Long-term land use (year 2018).

The development/redevelopment phasing as well as the near- and long-term land use projections will comprise an estimate of what the future land use scenarios may be, but will be developed based on the best available information. Conservative land use scenarios, i.e. the scenario leading to the highest water usage and/or wastewater flow production in the shortest timeframe, will be considered for the purpose of the Water and Sewer Master Plan.

Land Use Database

Several databases are available and were considered for use in developing the existing and future land use maps. These databases are described below.

- Planning Department FileMaker database

  This database was converted from an earlier VAX based database. According to the Planning Department, the conversion has not yet been checked and presents an unknown degree of errors (5 to 10% anticipated). In addition, the database has not been updated since 1998 and, therefore, does not account for many significant changes in land use that occurred since then. The database would have to be reconciled and updated prior to use. In addition, the database would have to be converted to a useable format for input into the hydraulic models.

- County Geographic Information System database

  The database includes both the parcel and existing land use information. The land use information is theoretically updated on a quarterly basis. The City would have to purchase the County Geographic Information System (GIS) data from Barclay Mapworks for $1.50 per parcel. However, according to the City staff, the County database is not reliable. In addition, the County GIS database would not be compatible with the City GIS database. It was agreed that using the County database was not the preferable option.

- City Geographic Information System database

  The City GIS database is under development. The parcels and street centerlines shapefiles (ArcView format) are already available. Land use information is not yet an attribute of the parcels. It would have to be developed. The zoning information and the citywide ortho-photo can be overlaid on the parcel map using ArcView GIS software to help developing the land use attributes. The sewer, water and recycled water system shapefiles are still under development and would not be available for incorporation into this Water and Sewer Master Plan.

The City GIS database was identified as the most appropriate database for the purpose of the Water and Sewer Master Plan. It would provide for a reliable land use GIS database, consistent with GIS databases under development such as the water and sewer system, and recycled water system. Other GIS databases that would be useful for future planning efforts, such as a customer complaint GIS database, could also be developed consistently with the land use GIS database.

Existing Land Use

Existing land use data will be combined with wastewater flow factors and diurnal flow patterns to distribute wastewater flows in the computer model of the existing collection system. FY 00/01 water billing data will be used directly to distribute water demand in the computer model of the existing distribution system. However, existing land use data will be used along with FY 00/01 water billing data to calibrate water use factors that will be required to evaluate future water demands.

A list of land use classifications was developed to reflect land uses with similar water use/wastewater flow characteristics. This classification is based on the General Plan and Midtown Specific Plan land use designations and the land use categories developed for the 1994 Water and Sewer Master Plan. A total of 21 land use categories were identified. The land use classification does not necessarily resemble the City's water billing classification. Table 1 provides the list of land use categories, along with descriptions based on zoning information.

Table 1: Existing Land Use Zoning Categories and Associated Densities

Land Use Categories	Code	2001 Densities		
		Residential Density (DU/acre)[a]	Persons/ DU[a,b]	Maximum FAR[a,c]
Valley Floor Residential				
Single-Family Low	SFL	1 DU/parcel[c]	3.7	-
Single-Family Medium	SFM	1 DU/parcel[d]	3.5	-
Multifamily Medium	MFM	8[f]	3.4	-
Multifamily High	MFH	16[b,f,g]	2.9[g]	-
Mobile Home Park	MHP	10.5[h]	1.6	-
Hillside Residential				
Single-Family Very Low	HVL	up to 0.1	3.7	-
Single-Family Low	HL	up to 1	3.7	-
Single-Family Medium	HM	up to 3	3.7	-
Commercial				
Town Center	TC	up to 40	3	0.85
Retail Sub-center	RSC	-	n.a.	0.35
General Commercial	CMRL	-	n.a.	0.5
Professional/Administrative Offices	PAO	-	n.a.	0.5
Industrial				
Industrial Park	INDP	-	n.a.	0.4
Manufacturing/Warehousing	IND	-	n.a.	0.5
Other				
Large Water Use	LWU	Water usage over 30,000 gpd. Includes jail, industrial users, and malls. Does not include hotels and schools.		
Large Hotel	Hotel	Large hotels (more than 80 rooms).		
Public/Semi-public	CVC	Includes churches, theaters, City Hall, fire station, police station,		
Schools	SCHL	Includes school buildings and their parking lots. Excludes irrigated playing field.		
Parks/Recreation Irrigated	PRKI	Includes parks, golf courses, schools playing fields, irrigated street meridians, cemeteries, playgrounds, etc.		
Open Space Non Irrigated	PRK	Includes stream banks, water supply and reservoirs.		
Undeveloped/Vacant Area	Vacant			

[a] Source: City of Milpitas General Plan, December 1994, Amended June 1998
[b] Adjusted per Census 2000 data
[c] The Floor-Area Ratio (FAR) is defined as the ratio of floor area to gross acreage.
[d] 7 DU/acre on average based on FY00/01 water use records
[e] 11 DU/acre on average counting units on Aerial map
[f] Planning Division staff input
[g] Future Residential Density value is 22 DU/acre and future Persons/DU value is 2.7 per Planning Division staff
[h] Based on FY00/01 water use records

The following information was combined to create the existing land use map (as of June 2001):

- The Zoning Map

  The zoning map provided by the City was overlaid on the parcel map using ArcView GIS Version 3.1 to create the land use base map. Some adjustments were required, as the zoning map did not overlay exactly on the parcel map. The land use base map was then modified manually to account for the additional information listed below.

- The City of Milpitas General Plan

  The General Plan was used to identify areas where the actual land use differs from the zoning information.

- The City of Milpitas Ortho-Photo

  The 1999 citywide ortho-photo was used to identify developed/undeveloped areas. It was also used to verify the type of land use on certain parcels as the zoning categories did not always correspond to the land use categories.

- Planning Department Input

  The Planning Department staff identified vacant developable parcels on the June 2000 zoning map, unique land uses areas, and large water users.

- Service Start-Date Data

  Service start-date data provided by the City of Milpitas was used to identify parcels developed between June 2000-June 2001.

- Occupancy Data

  The City does not keep track of building occupancy. Water use records were used to estimate the occupancy of newly developed buildings west of I-880 as of June 2001. Depending on how model calibration work proceeds, additional field surveys might be required to estimate the extent of vacancies in "old" industrial/commercial/office areas as of June 2001.

- FY 00/01 Water Records

  Wastewater flows for large water users may be developed as point sources, rather than calculated directly based on land use acreages. Winter average water use is typically used to estimate wastewater flows. Large water users were defined as using more than 30,000 gallons per day (gpd) and identified by analyzing the FY 00/01 water records. Table 2 shows a list of the identified large water users, their FY 00/01 average water use, and their winter average water use. The winter average water use was defined as the average water use over the November 2000-February 2001 period.

Table 2: Large Water Users

	H_2ONET Node ID	Manole # (G-ID)	Street Name	FY 00/01 Average Water Use (gpd)[a]	Winter Average Water Use (gpd)[a,b]
1	1855	1370	Abel St.	297,600	307,600
2	2006	839	Milpitas Blvd.	236,900	250,500
3	2516	635	McCarthy Blvd.	231,900	231,400

Footnotes:

a. Source: FY 00/01 Water Records provided by the City of Milpitas

b. Average water use over the November 2000-February 2001 period

Table 2: Large Water Users (ctd)

	H_2ONET Node ID	Manole # (G-ID)	Street Name	FY 00/01 Average Water Use (gpd)[a]	Winter Average Water Use (gpd)[a,b]
4	2808	928	Tarob Ct.	190,800	188,300
5	2514	639	Buckeye Ct.	175,900	174,200
6	2006	836	Milpitas Blvd.	166,500	154,400
7	2010	847	Hillview Dr.	163,500	160,600
8	3009	250	Ames Ave.	149,700	162,400
9	2510	605	McCarthy Blvd.	99,600	93,200
10	2010	847	Hillview Dr.	85,200	89,200
11	2007	836	Los Coches St.	76,800	69,700
12	29080	1299	Main St.	75,200	73,600
13	2516	847	Hillview Dr.	74,500	79,300
14	2816	928	Tarob Ct.	64,100	64,200
15	2003	849	Yosemite Dr.	46,500	44,800
16	1613	1398	Barber Ct.	41,300	43,000
17	1613	1390	Barber Ct.	31,600	31,700

Footnotes:
a. Source: FY 00/01 Water Records provided by the City of Milpitas
b. Average water use over the November 2000-February 2001 period

Map 2 is the existing land use map created for the Water and Sewer Master Plan. The parcel shapefile, including the existing land use information as an attribute, will be provided to the City in electronic format. Table 3 summarizes the existing land use acreage by land use category that was calculated using parcel size information from the City GIS database.

Table 3: Existing Land Use Acreage and Associated Population by Land Use Category

Land Use Designation	Code	Estimated Acreage		Estimated Population
		Acres	% of Total	
Valley Floor Residential				
Single-Family Low	SFL	1,435	23.8	35,600
Single-Family Medium	SFM	170	2.8	5,700
Multifamily Medium	MFM	215	3.6	5,700
Multifamily High	MFH	170	2.8	10,800
Mobile Home Park	MHP	55	0.9	1,000
Sub-Total		**2,045**	**33.9**	**58,800**

Table 3: Existing Land Use by Land Use Category (ctd)

Land Use Designation	Code	Estimated Acreage		Estimated Population
		Acres	% of Total	
Hillside Residential				
Single-Family Very Low	HVL	15	0.2	10
Single-Family Low	HL	115	1.9	220
Single-Family Medium	HM	30	0.5	360
Sub-Total		**160**	**2.6**	**590**
Commercial				
Town Center	TC	65	1.1	
Retail Sub-center	RSC	60	1.0	**NA**
General Commercial	CMRL	265	4.4	
Professional/Administrative Offices	PAO	40	0.7	
Sub-Total		**430**	**7.2**	
Industrial				
Industrial Park	INDP	530	8.8	**NA**
Manufacturing/Warehousing	IND	760	12.6	
Sub-Total		**1,290**	**21.4**	
Other				
Large Water Use	LWU	270	4.5	
Large Hotel	Hotel	45	0.7	
Public/Semi-public	CVC	60	1.0	
Schools	SCHL	205	3.4	**NA**
Parks/Recreation Irrigated	PRKI	315	5.3	
Open Space Non Irrigated	PRK	365	6.0	
Undeveloped/Vacant Area	Vacant	850	14.1	
Sub-Total		**2,110**	**35.0**	
Total		**6,035**	**100.0**	**59,390**

Future Land Use

Future land use data will be combined with wastewater flow and water use factors to determine projected wastewater flows and water demands.

The influence of Silicon Valley growth on the City policy in terms of land use makes it difficult to assess future land use. It was agreed that the most conservative of the reasonable scenarios, i.e. the scenario leading to the highest water usage and wastewater flow production within the shortest time period, should be considered for the purpose of the Water and Sewer Master Plan.

The existing land use map served as a base map to develop the interim and "ultimate" land use maps. Meetings were held with the Planning Department of the City of Milpitas to discuss specific areas of future development/redevelopment, and identify reasonable scenarios. Documents, including the City of Milpitas General Plan and the Milpitas Midtown Specific Plan, were reviewed. The information on the type, phasing and timing of development and redevelopment between 2001-2018 that was obtained through these discussions and from the documents is summarized on the next page.

- Vacant Land Development in the Valley Floor Area

  The area west of I-880 represents most of the vacant developable acreage in the Valley Floor area. It is mostly undeveloped industrial/commercial/office lands. The General Plan land use map was used as a reference to create the future land use maps, unless suggested otherwise by the Planning Department staff. For example, a large hotel (362 rooms) is anticipated for a parcel classified under "industrial park" in the General Plan.

  Other vacant developable parcels are scattered throughout the City. The General Plan and the Midtown Specific Plan land use maps were used as a reference to create the future land use maps, unless suggested otherwise by the Planning Department staff. For example, the recommended land use alternative shows general commercial use for the parcels located north and west of the Elmwood Rehabilitation Center. The Planning Department staff mentioned that the land use could also include a residential component, probably limited to 21-30 DU/acre due to the presence of adjacent single-family neighborhood.

  According to the Planning Department, the timing of development of the Valley Floor area between 2001-2018 will largely depend on economic growth. According to the Planning Department staff, planned Valley Floor residential areas and undeveloped industrial/commercial/office acreage were anticipated to be developed by the year 2005 assuming the economic growth of years 1999-2000. For the purpose of the Water and Sewer Master Plan, it is assumed that all vacant parcels in the Valley Floor area will be developed by 2008, except for some parcels within the Midtown planning area that are anticipated to be developed according to the Midtown Specific Plan.

- Vacant Land Development in the Hillside Area

  As a result of City Ordinance No. 38742, which fixed the limits of the City service area to the urban growth boundary on a 20-year horizon, only one significant change is anticipated to occur in the Hillside area before December 2018, a 28-dwelling unit project on the Murphy Ranch property. For the purpose of the Water and Sewer Master Plan, it is assumed that this project would be implemented after year 2008, since there are no existing permit applications or plans on file with the City.

- Redevelopment in the Valley Floor Area

  The Valley Floor area is entering a redevelopment era. The City has established a special planning area in the central portion of the City, called the Midtown Specific Plan area, which focuses on redevelopment of old industrial and commercial areas. This is the major redevelopment area in the City. Other areas of potential redevelopment were identified by the Planning Department staff and incorporated in the future land use estimates.

  <u>Midtown Specific Plan</u>

  The proposed land uses in the Midtown Specific Plan area include new land use categories such as mixed use, multifamily very-high density and overlay zones. Table 4 summarizes the new densities as drafted by the Midtown Specific Plan Subcommittee (EDAW, August 2001).

  Several land use alternatives were developed as part of the Midtown Specific Plan. The recommended land use alternative detailed in the Milpitas Midtown Specific Plan (EDAW, August 2001) was used for the purpose of the Water and Sewer Master Plan.

The implementation of the Midtown Specific Plan is scheduled to begin during 2002. The plan is anticipated to be 50% complete by 2007, and 100% complete by 2020. The Planning Department staff provided an estimate of the timing of development for each specific sub-area.

Table 4: Midtown Specific Plan Land Use Categories[a]

Land Use Designation	Code	Description		
		Residential Density (DU/acre)	Person/DU	Maximum FAR
Residential				
Multifamily Very High	MFVH	31-40	27	n.a.
Commercial				
Mixed Use	MXD	21-30	2.7	0.75
Overlay Districts				
Multi-Family Very High with TOD[b] Overlay Zone	MFVH-TOD	41-60	2.7	n.a.
Mixed Use with TOD Overlay Zone	MXD-TOD	31-40	2.7	1.0
Manufacturing/Warehousing with TOD Overlay Zone	IND-TOD	n.a.	n.a.	0.4
Gateway Office Overlay Zone	CMRL-OO	n.a.	n.a.	1.5

Footnotes
a. Source: Milpitas Midtown Specific Plan, Draft (EDAW, August 2001).
b. Transit Overlay District

Other areas of potential redevelopment

The other areas of potential redevelopment exclude existing residential areas, or new commercial/R&D areas. The areas identified by the Planning Department staff are described below:

- Industrial area east of Union Pacific Railroad between E. Calaveras Blvd. and Montague Expressway. Some parcels/areas with low intensity industrial use (FAR<0.2) will be replaced by newer projects with FAR upwards of 0.4. The redevelopment is anticipated to occur by 2005/2010, depending on the area.
- Town Center. An increase in commercial FAR (up to 200% increase) or a mix of retail and multi-family high density (up to 40 DU/gross acre) is anticipated. The redevelopment is anticipated to occur by 2010. For the purpose of the Water and Sewer Master Plan, it is assumed that the identified parcels will be redeveloped under the long-term scenario.
- Parcels located to the south west of the I-680/Calaveras Blvd. intersection. This area (existing skating rink and building supply store) will likely be converted to a fairly large hotel (70-80 rooms/gross acre), multi-family high-density residential area (up to 40 DU/gross acre), or a combination of both. The redevelopment is anticipated to occur by 2005.
- Parcels located to the south east of the I-680/Calaveras Blvd. intersection. This area will likely be converted to a multi-family high-density residential area (up to 40 DU/gross acre), or retail/residential mixed use (20-30 DU/gross acre). The redevelopment is anticipated to occur by 2005/2010, depending on the area.
- Construction site east of Union Pacific Railroad on Milpitas Blvd. at Hanson Ct. This area will eventually change to multi-family high-density residential (probably no more than 30 DU/gross acre due to single-family neighborhood across the street). The anticipated timing for this

redevelopment is 2010. For the purpose of the Water and Sewer Master Plan, it is assumed that the identified parcels will be redeveloped under the long-term scenario.

The near- and long-term land use maps were created based on the information on the type, phasing and timing of development and redevelopment between 2001-2018 summarized above.

Map 3 and Map 4 are the near- and long-term land use maps created for the Water and Sewer Master Plan. For the reader's convenience, only the land use changes from the existing land use are shown on the map. The parcel shapefile, including the near- and long-term land use information as an attribute, will be provided to the City in electronic format. Table 5 summarizes the future land use acreage by land use category that was calculated using parcel size information from the City GIS database.

Table 5: Future Land Use Acreage by Land Use Category

Land Use Category	Code	Estimated Acreage					
		2008		2018		Midtown Buildout	
		Acres	% of Total	Acres	% of Total	Acres	% of Total
Valley Floor Residential							
Single-Family Low	SFL	1,440	23.9	1,440	23.9	1,440	23.9
Single-Family Medium	SFM	170	2.8	170	2.8	170	2.8
Multifamily Medium	MFM	215	3.6	215	3.6	215	3.6
Multifamily High	MFH	180	3.0	195	3.2	195	3.2
Multifamily Very High	MFVH	15	0.2	50	0.8	75	1.3
Mobile Home Park	MHP	55	0.9	55	0.9	55	0.9
Sub-Total		**2,075**	**34.4**	**2,125**	**35.2**	**2,150**	**35.7**
Hillside Residential							
Single-Family Very Low	HVL	15	0.2	15	0.3	15	0.3
Single-Family Low	HL	115	1.9	115	1.9	115	1.9
Single-Family Medium	HM	30	0.5	30	0.5	30	0.5
Sub-Total		**160**	**2.6**	**160**	**2.7**	**160**	**2.7**
Commercial							
Town Center	TC	65	1.1	35	0.5	10	0.1
Retail Sub-center	RSC	65	1.1	65	1.0	60	1.0
General Commercial	CMRL	305	5.0	315	5.2	240	4.0
Professional/Administrative Offices	PAO	45	0.8	45	0.8	45	0.7
Mixed Use	MXD	--	--	10	0.1	95	1.6
Sub-Total		**480**	**8.0**	**470**	**7.6**	**450**	**7.4**
Overlay Districts [a]							
Multifamily Very High with TOD	MFVH-TOD	30	0.5	65	1.1	85	1.4
Mixed Use with TOD	MXD-TOD	15	0.3	15	0.3	35	0.6
Manufacturing/Warehousing TOD	IND-TOD	-	-	-	-	105	1.8
Gateway Office Overlay Zone	CMRL-OO	5	0.0	15	0.2	20	0.3
Sub-Total		**50**	**0.8**	**95**	**1.6**	**245**	**4.1**

Table 5: Future Land Use Acreage by Land Use Category (ctd)

Land Use Category	Code	Estimated Acreage					
		2008		2018		Midtown Buildout	
		Acres	% of Total	Acres	% of Total	Acres	% of Total
Industrial							
Industrial Park	INDP	750	12.4	785	13.0	785	13.0
Manufacturing/Warehousing	IND	785	13.0	745	12.3	710	11.7
Sub-Total		**1,535**	**25.4**	**1,530**	**25.3**	**1,495**	**24.7**
Other							
Large Water Use	LWU	250	4.2	250	4.2	240	4.0
Large Hotel	Hotel	50	0.8	50	0.8	50	0.8
Parks/Recreation Irrigated	PRKI	320	5.3	320	5.3	325	5.4
Public/Semi-public	CVC	65	1.1	65	1.1	40	0.7
Schools	SCHL	205	3.4	205	3.4	205	3.4
Open Space Non Irrigated	PRK	365	6.1	365	6.1	365	6.1
Undeveloped/Vacant Area	Vacant	485	8.0	405	6.7	315	5.2
Sub-Total		**1,740**	**28.9**	**1,660**	**27.6**	**1,540**	**25.6**
Total		**6,040**	**100**	**6,040**	**100**	**6,040**	**100**

[a] Transit Oriented Development (TOD) overlay zones are areas located approximately within a quarter-mile radius of the transit stations where special development standards (i.e. density and parking requirements) are tailored to the area's proximity to the transit stations

LEGEND

City Limits

Urban Growth Boundary

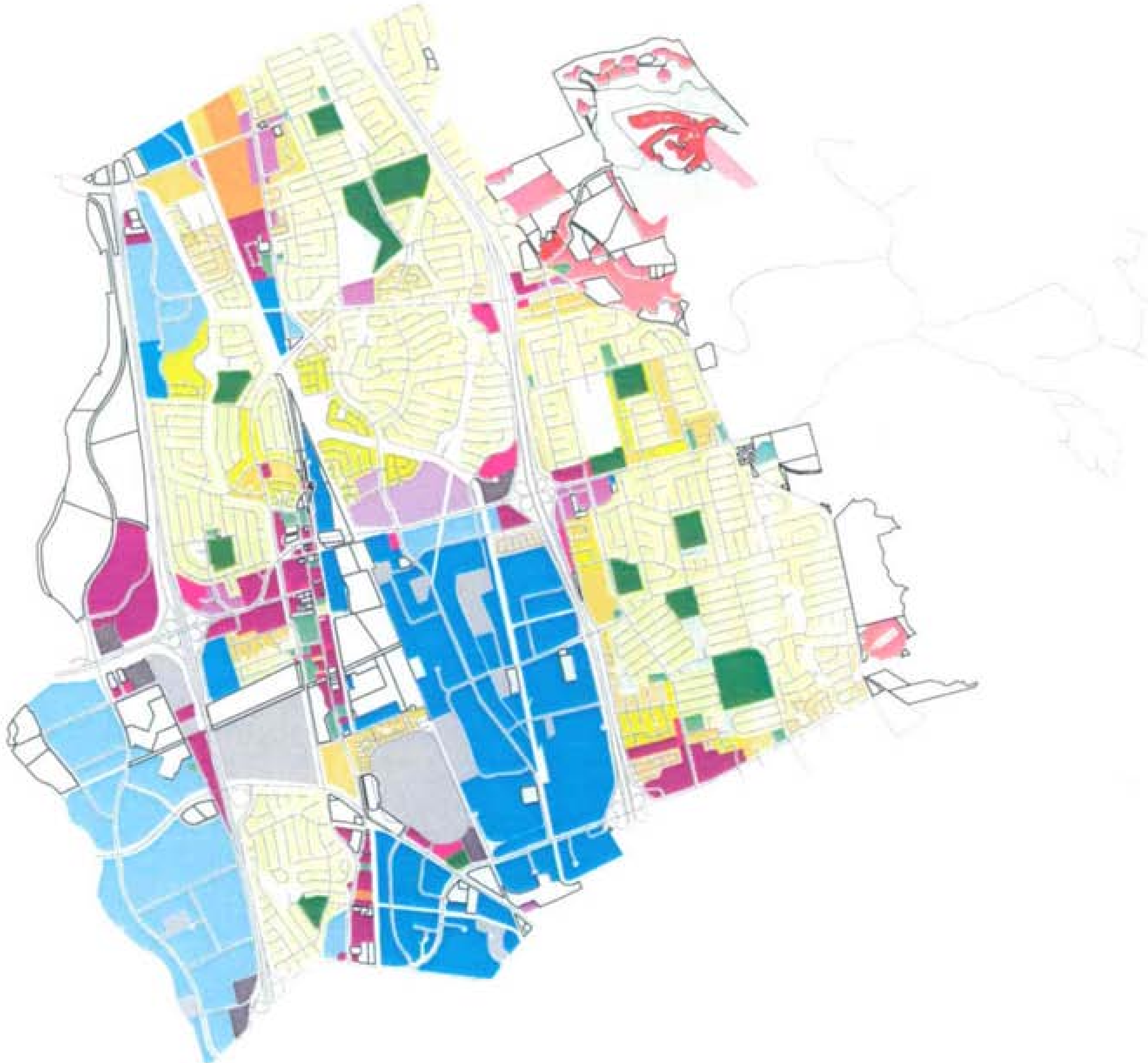
Urban Service Area

Map 1
Study Area

City of Milpitas

N

0 0.3 0.6 Miles



LEGEND

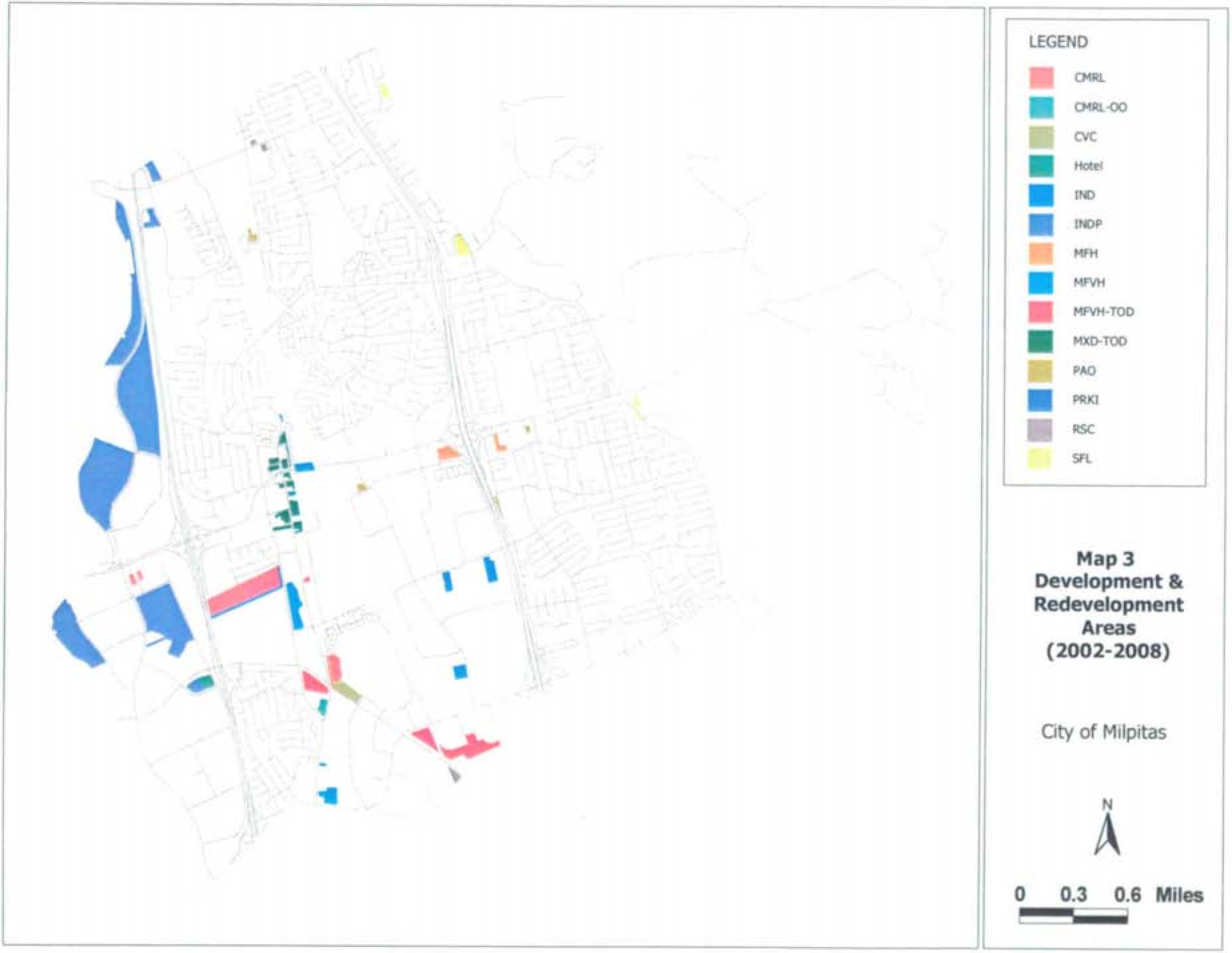
- Single Family Low
- Single Family Medium
- Multi-Family Medium
- Multi-Family High
- Mobile Home Park
- Hillside Very Low
- Hillside Low
- Hillside Medium Density
- Town Center
- Retail Sub-Center
- Professional/Admin. Offices
- General Commercial
- Industrial Park
- Manufacturing/Warehousing
- Large Water Use
- Large Hotel
- Parks/Recreation Irrigated
- Public/Semi-Public
- Schools
- Open Space Non Irrigated
- Undeveloped/Vacant

Map 2
Existing Land Use
(as of June 2001)

City of Milpitas

N

0 0.3 0.6 Miles


LEGEND
CMRL
CMRL-OO
CVC
Hotel
IND
INDP
MFH
MFVH
MFVH-TOD
MXD-TOD
PAO
PRKI
RSC
SFL
Map 3
Development &
Redevelopment
Areas
(2002-2008)
City of Milpitas
N
0
0.3
0.6
Miles

Map 4
Development & Redevelopment Areas
(2009-2018)

City of Milpitas

APPENDIX B

DRY WEATHER FLOW MONITORING TM (2002)

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject:	Dry Weather Wastewater Flow Monitoring
Prepared For:	Aparna Chatterjee
Prepared By:	Helene Kubler
Reviewed By:	Justine Faisst Tom Richardson
Prepared By:	File, Darryl Wong, Marilyn Nickel
Date:	June 2001 (DRAFT) December 2002 (FINAL)
Reference:	051.0070

Dry weather wastewater flow factors and diurnal flow patterns are the key to estimating existing and future dry weather wastewater flows. These will be used to develop a dynamic computer model of the collection system and determine the future dry weather treatment capacity needs of the City of Milpitas at the San Jose/Santa Clara Pollution Control Plant. The computer model will be the basis for estimating necessary wastewater collection system improvements and developing a capital improvement program.

The purpose of the dry weather flow monitoring program was to provide data to estimate the base wastewater flow (BWF) factors and establish the diurnal flow patterns associated with different types of land use.

The appropriateness of the estimated unit BWF factors and diurnal flow patterns will need to be later verified/refined by:

- Computing the average BWF flow for all of Milpitas and comparing it to the actual metered flow at the Main PS
- Computing the average BWF flow generation per land use category and comparing it to the winter water use
- Running the hydraulic model and comparing calculated hourly flow with metered flow at several locations in the system

This Technical Memorandum (TM) presents the results of the dry weather wastewater flow monitoring program conducted for the City of Milpitas Sewer Master Plan.

This memorandum is organized as follows:

Introduction
Flow Monitoring Program
Flow Data Analysis
Summary & Conclusions

Note: All maps and figures can be found at the end of the memorandum.

Introduction

Wastewater flow factors and diurnal flow patterns associated with different types of land use are required to develop a dynamic computer model of the collection system and to determine the dry weather treatment capacity needs of the City of Milpitas at the San Jose/Santa Clara Pollution Control Plant. The reliability of the computer model and treatment capacity estimates depends to a large extent on the appropriateness of the BWF factors and diurnal flow patterns.

Table 1 summarizes the unit BWF factors by land use category used in the 1994 Sewer Master Plan Update (Carollo Engineers, June 1994). The residential flow in this plan was based upon then current water meter records and general wastewater generation rates used for adjacent bay cities' studies. Commercial and public school sewer contributions of 2,500 gallons per acre per day (gpd/acre) were taken from the 1984 Sewer Master Plan. Industrial sewer contributions were reduced from 6,000 gpd/acre in the 1984 Sewer Master Plan to 3,000 gpd/acre to calibrate flows predicted by the model with observed flows.

Table 1: Wastewater Flow Factors by Land Use Category Used in the 1994 Sewer Master Plan Update

Land Use Category	Unit	Unit BWF Factor	
		Year 1994	Year 2010
Residential	gpd/capita	75	75
Commercial	gpd/net acre[a]	2,500	2,500
Industrial	gpd/net acre[a]	3,000	3,000

Notes:
1. BWF: base wastewater flow

Footnotes
a. The net acreage is defined as the gross area minus an allowance for non-developed area, i.e. right-of-way.

Now, changes in the wastewater generation by land use type are anticipated as a result of water conservation, transition from traditional to high-tech industrial activities and increased unit water use in new commercial areas. Therefore, it is recommended that the BWF factors used in the 1994 Sewer Master Plan be updated for the purpose of this Master Plan.

In addition, the computer model previously developed was a static model that used a peaking factor (ratio of the peak to the average wastewater flow) rather than diurnal flow patterns. The time variations in flow were not analyzed in the previous master plan. The transition from a static model to a dynamic computer model requires establishing the diurnal flow pattern associated with the different types of land use.

The purpose of the dry weather flow monitoring program was to provide data to update the BWF factors used for the City's 1994 Sewer Master Plan and to establish the diurnal flow pattern associated with different types of land use.

Flow Monitoring Program

The City of Milpitas dry weather flow monitoring program consisted of eight temporary flow meters installed for a two-week and three-weekend period. The following sections describe the different tasks that were involved as part of the flow monitoring program.

Period Selection

A two-week and three-weekend period was selected to provide the opportunity to collect sufficient data to perform a meaningful analysis. The flow monitoring program was conducted from July 27 through

August 13, 2001, when there would be the lowest chance of groundwater infiltration occurring in the collection system and the greatest assurance of completely dry weather. The meter of Site 7 failed during the first week of the monitoring program. It was replaced on August 3, 2001 and left in place until August 20, 2001.

Site selection

The site selection included a number of factors such as uniformity of land use in the monitored area, size of the monitored area, access to the manholes and flow configuration within the manhole. Monitoring eight sites provided the best opportunity to collect data for a number of distinct land use types.

Information used to locate manholes throughout the City where meaningful data could be collected was gathered from the following sources:

- Existing and Future Land Use Estimates Technical Memorandum (RMC, September 2001);
- Groundwater Infiltration (GWI) Evaluation (Kennedy/Jenks Consultants, October 1999);
- City of Milpitas Ortho-Photo (City of Milpitas, July 1999);
- City of Milpitas General Plan (City of Milpitas, December 1994, Amended June 1998);
- Map of Age of the Sewers provided by the City of Milpitas (The age of the sewers was used as an indication of the timing of the land development, not as an indicator of the condition of the sewers);
- Sewer System 1"=100' Maps provided by the City of Milpitas; and,
- Discussions with the Public Works Department staff.

Table 2 summarizes information relevant to the monitored manholes, including the manhole number and location. Map 1 shows the location of the flow monitoring sites and the corresponding sewered area.

Table 2: Dry Weather Flow Monitoring Sites

	Manhole #[a]	Location	Pipe Size (Inches)	Predominant Land Use Type	Age of Sewers[b]	Sewered Area (acres)	Anticipated GWI
1	22-3-05	Starlite Dr at Galaxy Ct cross-section	8	Valley Floor Single-Family Low-Density	1960's	57	Yes
2	57-3-12[c]	Carnegie Dr between Canton Dr and Calaveras Blvd	10[d]	Valley Floor Single-Family Low-Density	1960's	178	No
3	28-3-10	Curtner Dr at Diel Dr cross-section	8	Valley Floor Single-Family Low-Density	1980's	57	No
4	15-3-03[c]	Gingerwood Dr between Pacifica Way and Jurgens Dr	8	Valley Floor Single-Family Medium-Density	1980's	15	No
5	8-6-01[c]	McCarthy Ranch Parking Lot between Ranch Dr and McCarthy Blvd	8	Commercial	1990's	28	Yes
6	22-3-08	Barber Lane between Sycamore Dr and Alder Drive	18	Industrial Park	1980's	212	Yes
7	46-1-01	Milpitas Blvd between Los Coches Street and Calaveras Blvd	18	Manufacturing/ Warehousing	1970's	199	Yes

	Manhole #[a]	Location	Pipe Size (Inches)	Predominant Land Use Type	Age of Sewers[b]	Sewered Area (acres)	Anticipated GWI
8	46-3-01	Along Beryessa Creek between Piedmont Creek and Los Coches St	15	Manufacturing/ Warehousing	Unknown	137	No

Footnotes:

a. Refers to the City of Milpitas Sewer System Nodal Map. The first two figures correspond to the sheet number in the City's Sewer System 1"=100' Maps.

b. The age of the sewers is used as an indication of the timing of the land development, not as an indicator of the condition of the sewers.

c. This is not the manhole that was metered, but it is the closest manhole shown on the City of Milpitas Sewer System Nodal Map.

d. The pipe configuration has changed from what is shown on the Sewer System 1"=100' Maps.

Sites 1 through 4 were selected to evaluate the BWF flow and diurnal flow pattern associated with residential land use. Approximately 63% of the residential acreage in the City is considered single-family low-density residential (RMC, September 2001), which is represented by Sites 1, 2 and 3. Each of these three sites represents a different timing of development (1960s vs. 1980s) and potential for groundwater infiltration. According to the General Plan, single-family medium-density residential, mobile home park, and multifamily medium-density residential land use designations present similar density range. These three categories represent approximately 19% of the residential acreage in the City. A fourth monitoring site, Site 4, was therefore chosen to collect flow data associated with a single-family medium-density residential area. This data was compiled to verify whether the use of a unique wastewater flow factor for the residential area is justified and, if so, identify what this value should be.

Approximately 60% of the commercial acreage in the City is considered general commercial (RMC, September 2001). Site 5 was selected to evaluate the BWF flow and diurnal flow pattern associated with this particular type of land use. The McCarthy Ranch area was preferred over an older commercial area, such as Main Street, for several reasons, including (1) the area is more dynamic and more representative of future commercial development, (2) the area is subject to groundwater infiltration and (3) a larger sewered area could be isolated than in the Main Street area.

Sites 6, 7 and 8 were selected to evaluate the BWF flow and diurnal flow pattern associated with industrial land use. Approximately 35% of the industrial acreage in the City is considered industrial park, while the remaining 65% falls under the manufacturing/warehousing category (RMC, September 2001). Site 6 evaluated the wastewater flows associated with industrial park, whereas Site 7 and 8 evaluated the wastewater flows associated with manufacturing/warehousing. Site 7 sewered area encompasses heavier industries than Site 8 sewered area. The Site 6 and 7 sewered areas are anticipated to be subject to groundwater infiltration.

The total area in the monitored sites was 883 acres, i.e. approximately 15% of the total Valley Floor area.

Field Reconnaissance

Some field reconnaissance was performed to verify the types of land use within the monitored areas.

Prior to installing the flow meters, RMC's subconsultant, E2 Consulting Engineers, inspected all of the monitoring sites to verify access to manholes, assess their suitability for equipment installation, and determine the size of the pipes to be monitored and the most appropriate monitoring equipment to use.

Flow Monitoring Fieldwork

E2 Consulting Engineers conducted the flow monitoring program fieldwork. The program utilized SIGMA 910 flow meters, which record both the depth and velocity of the flow. This data is then processed to calculate the resulting flow rate based on the continuity equation. Meter calibration was accomplished by taking manual measurements of flow depth and velocity in the flow stream. The flow monitoring crew visited the meter sites at least weekly to check the meters, retrieve data and obtain field calibration measurements.

Flow Calculation

E2 Consulting Engineers performed the flow calculations. E2's flow monitoring report, including field reconnaissance information and flow data plots, is provided in Attachment A.

Flow Data Analysis

The focus of the flow data analysis was to update the BWF factors used for the City's 1994 Sewer Master Plan and establish the diurnal flow pattern associated with different types of land use. Three major types of land use were considered: residential, commercial, and industrial. The flow data for each metered site was reviewed and analyzed in order to estimate the BWF factor and the diurnal flow pattern that would represent these types of land use. The following sections describe the results of the flow monitoring for each site by type of land use.

It should be noted that the analysis of average dry weather flows includes the evaluation and subtraction of a groundwater component from the average flows. Although the flow monitoring was conducted during a period when there would be the lowest chance of groundwater infiltration occurring in the collection system, high nighttime minimum flows observed at some of the sites proved to be due not only to wastewater being discharged on a 24-hour basis but also to groundwater infiltration. The Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 1999) study was used to segregate wastewater being discharged on a continuous basis from groundwater infiltration for the different monitoring sites.

It should also be noted that no rain fell during the flow monitoring period.

The following notations are used throughout the analysis:

GWI	Average Daily Groundwater Infiltration
ABWF	Average Daily Base Wastewater Flow
AWF	Average Daily Wastewater Flow
Min	Minimum Flow
Max	Maximum Flow
BWF Factor	Unit Base Wastewater Flow Factor
	BWF Factor = ABWF per net acre/people per net acre, for residential land use
	BWF Factor = ABWF/net acreage, for non-residential land use

The following industry-standard relationships were assumed for the flow data analysis:

AWF = ABWF + GWI

Ratio to Average Flow = (Hourly Flow – average GWI)/average ABWF

ABWF ~ 1.25 × (AWF – Min) in residential areas

GWI = 0.9 × (Min – Continuous Flow) in commercial/industrial areas

Residential Areas

The monitored areas are predominantly single-family low-density (SFL) or single-family medium-density (SFM) residential area. They also encompass multifamily high-density residential (MFH), irrigated parks (PRKI), the Zanker Elementary School and Alexander Rose Elementary School (SCHL), and vacant parcels (Vacant). It is assumed that the irrigated parks and vacant parcels do not contribute directly to sanitary sewer flow generation. The schools were not in session during the flow monitoring period. It was therefore assumed that the schools did not contribute to wastewater flow generation during the flow monitoring period. Table 3 summarizes the land use acreage by land use category as well as other relevant information, including the number of dwelling units (DU) and capita per dwelling unit (capita/DU).

Table 3: Land Use Acreage by Monitoring Site and Land Use Category

Monitoring Site	Land Use Category	Acreage (acres)[a]	DU[b]	capita/DU[c]
Site 1	SFL	37	345	3.7
	PRKI	13	NA	NA
	SCHL	7	NA	NA
	Total Site 1	**57**		
Site 2	SFL	160	1035	3.7
	PRKI	5	NA	NA
	SCHL	12	NA	NA
	Vacant	1	NA	NA
	Total Site 2	**178**		
Site 3	SFL	52	195	3.7
	PRKI	5	NA	NA
	Total Site 3	**57**		
Site 4	SFM	14.5	185	3.5
	MFH	0.5	30	2.9
	Total Site 4	**15**		

Notes:
1. DU: Dwelling Unit; capital/DU: capita per dwelling unit; NA: Not Applicable

Footnotes:
a. Source: City of Milpitas GIS parcel database (PA_2001.shp)
b. The number of dwelling units per acre was estimated using the parcel database from the City of Milpitas, assuming one DU per parcel for SFL and SFM. Rounded to the nearest 5.
c. Source: City of Milpitas General Plan (City of Milpitas, December 1994, Amended June 1998).

The flow data for each site was reviewed and analyzed using the land use information summarized above in order to estimate the dry weather wastewater flow factor and the diurnal flow pattern that would best represent the residential land use.

Base Wastewater Flow Factor

The average ABWF and GWI over the flow monitoring period were estimated based on the flow data provided by E2. Table 4 summarizes the monitored flows, estimated average ABWF and GWI over the monitoring period by monitoring site.

Table 4: Monitored Flows – Estimated ABWF and GWI by Monitoring Site

Monitoring Site	Estimated Average Winter Water Use (mgd)[a]	Monitored Flows (mgd)			Estimated Average ABWF (mgd)[a]	Estimated Average GWI	
		Average AWF	Min	Max		mgd	gpd/acre[b]
Site 1	0.099	0.073	0.016	0.153	0.062	0.011	200
Site 2	0.331	0.302	0.064	0.483	0.284	0.018	100
Site 3	0.074	0.037	0.004	0.083	0.036	0.001	-
Site 4	0.051	0.045	0.001	0.448	0.040	0.005	250

Footnotes:
a. Assuming that ABWF ~ 1.25*(AWF – Min)
b. Rounded to the nearest 50

The estimated average GWI over the flow monitoring period at Sites 1 and 4 represents more than 10% of the average AWF over the same period. This percentage is above the range of accuracy of the flow monitoring equipment, and groundwater infiltration was anticipated in these areas. Consequently, GWI will be accounted for when computing the DWWFF.

The estimated average GWI over the flow monitoring period at Site 2 represents less than 10% of the average AWF over the same period. This percentage is below the range of accuracy of the flow monitoring equipment, and little to no groundwater infiltration was anticipated during the monitoring period in these areas. Therefore, GWI will not be accounted for when computing the DWWFF.

The average AWF for Site 3 is significantly lower than the winter water use estimated from the water use records provided by the City of Milpitas. After verification of the linkage between water records and parcel data, it was estimated that the winter water use number was reliable. It was decided to discard the average flow data for Site 3 in estimating the BWF factors.

BWF factors associated with monitoring area, except Site 3, were estimated using the average AWF, estimated GWI and land use information. Table 5 provides the results of this analysis.

Table 5: Estimated BWF Factor by Monitoring Site

Monitoring Site	Reference Period	Average AWF (mgd)	GWI (mgd)	Average ABWF (mgd)	BWF Factor	
					gpd/acre[a]	gpd/capita[b]
Site 1	Week	0.073	0.011	0.062	1,700	50
	Weekday	0.071	0.011	0.060	1,600	50
	Weekend	0.078	0.011	0.067	1,800	55
Site 2	Week	0.301	-	0.301	1,900	80
	Weekday	0.299	-	0.299	1,900	80
	Weekend	0.306	-	0.306	1,900	80
Site 4	Week	0.043	0.005	0.038	1,900	50
	Weekday	0.041	0.005	0.036	1,800	50
	Weekend	0.052	0.005	0.047	2,400	65

Footnotes:
a. Rounded to the nearest 100
b. Rounded to the nearest 5

The BWF factors obtained for Sites 1 and 4 for the different reference periods are very similar in terms of gpd/capita, with the average weekend flows being consistently higher. Site 2 has a relatively high BWF factors compared to the other sites. This might be due to a higher water use per capita. However, the winter water use per capita estimated based on FY 00/01 water use records is consistent with water use in other areas. Another possibility would be some irrigation/landscape drainage connection, since the high flows are occurring only during the day.

It is recommended that a sensitivity analysis be performed using a BWF factor of 50 – 80 gpd/capita for residential land use. A BWF factor of 65 gpd/capita for weekday and 70 gpd/capita for weekend is suggested as a starting point. It should be noted that the BWF factor associated with Hillside residential area is anticipated to be larger than BWF factor associated with Valley Floor residential area. A BWF factor of 70 – 100 gpd/capita should be used for Hillside residential. A BWF factor of 85 gpd/capita for weekday and 90 gpd/capita for weekend is suggested as a starting point for Hillside residential. The purpose of the sensitivity analysis will be to refine the BWF factors by computing the average dry weather flow for all of Milpitas and comparing it to the actual metered flow at the main lift station during the monitoring period.

Diurnal Flow Pattern

Average weekday and weekend diurnal flow patterns (i.e. hourly flow to average flow ratio versus hour) were created for Sites 1, 2, 3 and 4 based on the hourly flow data. When appropriate, the groundwater infiltration component was subtracted from the hourly flow to establish the diurnal flow patterns. Figures 1 and 2 provide the diurnal flow patterns for weekday and weekend, respectively.

The diurnal flow patterns for Sites 1 and 3 follow a typical diurnal flow pattern, with the peak flow occurring in the morning hours between 7 and 8 a.m. on weekdays and approximately two hours later on weekends. The peak ratio to average flow for Site 1 is approximately 1.8 on weekends and 1.4 on weekdays. The peak ratio to average flow for Site 3 was approximately 1.8 on weekends and 1.7 on weekdays.

The diurnal flow patterns for Site 2 also follows a typical diurnal flow pattern, with the peak flow occurring in the morning hours between 7 and 8 a.m. on weekdays and approximately two hours later on weekends. The peak ratio to average flow for Site 2 is approximately 1.4 on weekends and 1.3 on weekdays. These relatively low values are due to the fact that the monitored sewered area is very large (approximately four times that associated with Site 1), which causes the diurnal curve to be smoothed out. As a consequence, the diurnal flow pattern obtained for Site 2 should not be used to estimate the diurnal flow pattern to be used in the computer model since the sewered area associated with each manhole is typically small. However, the hourly flow data from Site 2 will be used for later model calibration.

The diurnal flow patterns for Site 4 follows a typical diurnal flow pattern, with the peak flow occurring in the morning hours between 7 and 8 a.m. on weekdays and approximately three hours later on weekends. The peak ratio to average flow for Site 4 is approximately 1.6 on weekends and 2.0 on weekdays. Contrary to Site 1 and 3 diurnal flow patterns, the peak ratio to average flow on weekend at Site 4 is lower than that on weekday. However, as documented before, the average weekend flow for Site 4 is significantly higher than the average weekday flow. As a consequence, the peak flow on the weekend is higher than that on weekday, which is consistent with the flow observed at Sites 1 and 3.

It is recommended that the average of weekday and weekend diurnal flow patterns from Sites 1 and 3 be used as the diurnal flow pattern for residential land use. It is also suggested to use the weekday and weekend diurnal flow patterns from Site 4 for specific land use categories (Hillside residential land use categories, multi-family high density). It should be noted that more extreme peak flows could also occur under atypical conditions, such as during halftime on "Super Bowl Sunday."

Commercial Area

This monitoring area encompasses exclusively commercial (CMRL) land use in the McCarthy Ranch area. The commercial services in the monitored area mainly consist of restaurants. Table 6 summarizes the land use acreage by land use category as well as other relevant information.

Table 6: Land Use Acreage by Monitoring Site and Land Use Category

Monitoring Site	Land Use Category	Acreage (acres)[a]
Site 5	CMRL	28

Footnotes:
a. Source: City of Milpitas GIS parcel database (PA_2001.shp)

The flow data for Site 5 was reviewed and analyzed using the land use information summarized above in order to estimate the dry weather wastewater flow factor and the diurnal flow pattern that would best represent the commercial land use.

Base Wastewater Flow Factor

The average ABWF and GWI over the flow monitoring period were estimated based on the flow data provided by E2. Table 7 summarizes the monitored flows, estimated average ABWF and GWI over the monitoring period by monitoring site.

Table 7: Monitored Flows – Estimated ABWF and GWI by Monitoring Site

Monitoring Site	Estimated Average Winter Water Use (mgd)[a]	Monitored Flows (mgd)			Estimated Average ABWF (mgd)	Estimated Average GWI[b]	
		Average AWF	Min	Max		mgd	gpd/acre[c]
Site 5	0.052	0.072	0.020	0.146	0.050	0.022	800

Footnotes:
a. Based on Nov 2000 – February 2001 water use records provided by the City of Milpitas.
b. Assuming that GWI ~ 0.9*(Min – Continuous Flow)
c. Rounded to the nearest 100

The estimated average GWI over the flow monitoring period at Site 5 is representing more than 10% of the average AWF over the same period. This percentage is above the range of accuracy of the flow monitoring equipment, groundwater infiltration was anticipated in this area, and the estimated average ABWF is consistent with the average winter water use. Consequently, GWI will be accounted for when computing the BWF factor.

The BWF factor associated with this monitoring area was estimated using the average week ABWF. Table 8 provides the results of this analysis.

Table 8: Estimated BWF Factor by Monitoring Site

Monitoring Site	Reference Period	Average AWF (mgd)	GWI (mgd)	Average ABWF (mgd)	BWF Factor (gpd/acre)[a]
Site 5	Week	0.072	0.022	0.050	1,800
	Weekday	0.072	0.022	0.050	1,800
	Weekend	0.073	0.022	0.051	1,800

Footnotes:
a. Rounded to the nearest 100

The BWF factor for professional/administrative offices, general commercial and retail sub-center is typically ranging between 500 – 1,000 gpd/acre. The BWF factor obtained for Site 5 is significantly higher than these typical values. This might be due to the fact that Site 5 (McCarthy Ranch area) mainly consists of busy restaurants that were recently developed. This site might not be representative of the wastewater flows generated in some other older commercial areas of the City, such as along Main Street. However, it is likely representative of future commercial development areas.

It is recommended that a sensitivity analysis be performed using a BWF factor of 1,000 – 1,800 gpd/acre for commercial land use with a floor-area ratio (FAR) of 0.5. A BWF factor of 1,800 gpd/acre for weekday and weekend is suggested as a starting point for recent commercial development, and should be used for future commercial development similar to McCarthy Ranch Area. A BWF factor of 1,000 gpd/acre for weekday and weekend is suggested as a starting point for older commercial areas of the City. It is suggested that the BWF factor associated with commercial land use categories with a different FAR be calculated by using the ratio of the FAR (e.g. Town Center (TC) has a FAR of 0.85; the proposed BWF factor for TC would be $1{,}000 \times 0.85/0.5 = 1{,}700$ gpd/acre). These assumptions will be validated by computing the average dry weather flow for all of Milpitas and comparing it to the actual metered flow at the main lift station during the monitoring period.

Diurnal Flow Pattern

Average weekday and weekend diurnal flow patterns (i.e. hourly flow to average flow ratio versus hour) were created based on the hourly flow data. The groundwater infiltration component was subtracted from the hourly flow to establish the diurnal flow pattern. Figures 3 and 4 provide the Site 5 diurnal flow patterns for weekday and weekend, respectively.

The diurnal flow patterns for Site 5 follow a typical diurnal flow pattern for restaurants, with peaks at lunchtime and dinnertime. The peak ratio to average flow is approximately 2.0 at 1:00 pm on weekdays and 1.9 between 8 – 9:00 pm on weekdays and weekends.

It is recommended that the diurnal flow pattern for Site 5 be used for existing and future "restaurant-oriented" commercial development. A flatter diurnal flow pattern should be used for older commercial areas, town center, retail sub-center, and professional and administrative offices. In particular, the afternoon drop should be smoothed. The recommended diurnal flow pattern (referred to as COM_General) that was developed based on Site 5 diurnal flow pattern is shown on Figures 3 and 4.

Industrial Area

The monitoring areas are predominantly industrial park (INDP) or manufacturing/warehousing (IND) industrial area. The areas also encompass vacant parcels (Vacant), major hotels (Hotel) and large water users (LWU). The Hotel and LWU contribution was estimated based on FY 00/01 water use records. Based on the Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 1999) and information from the City, a number of industries in the monitored areas are operating 24-hour a day. The contribution of these industries was then estimated based on FY 00/01 water use records. Table 9 summarizes the land use acreage by land use category as well as other relevant information.

The flow data for each site was reviewed and analyzed using the land use information summarized above in order to estimate the dry weather wastewater flow factor and the diurnal flow pattern that would best represent the industrial land use.

Table 9: Land Use Acreage by Monitoring Site and Land Use Category

Monitoring Site	Land Use Category	Acreage (acres)[a]	Comments
Site 6	INDP	191	24-hour operation: Fairchild Imaging, IC Sensors, Linear Tech Corp., Quantum Corp., Standard Mem's Inc., Xicor.[b] Average daily water use: approximately 0.55 mgd.[c]
	LWU	10	LWU: Fairchild Imaging, Linear Tech Corp., Standard Mem's Inc. Average daily water use: approximately 0.50 mgd.[c]
	Hotel	11	Sheraton, Beverly Heritage. 466 rooms. Average daily water use: approximately 0.02 mgd.[c]
	Total Site 6	**212**	
Site 7	IND	158	24-hour operation: Adaptec, California Micro Devices, Seagate Recording Media, Seagate Technology Inc., Sipex.[b] Average daily water use: approximately 0.50 mgd.[c]
	LWU	32	LWU: Marzetti, Linear Technology, Seagate Technology Inc., Headway Technologies Inc., Read-rite. Average daily water use: approximately 0.71 mgd.[c]
	INDP	5	
	Vacant	4	
	Total Site 7	**199**	
Site 8	IND	130	24-hour operation: Arrowhead Drinking Water, U.S. Filter Corporation.[b] Average daily water use: approximately 0.19 mgd.[c]
	LWU	2	LWU: U.S. Filter Corporation. Average daily water use: approximately 0.17 mgd.[c]
	Vacant	5	
	Total Site 8	**137**	

Footnotes:
a. Source: City of Milpitas GIS parcel database (PA_2001.shp)
b. Based on Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 1999)
c. Based on FY 00/01 water use records provided by the City of Milpitas

Base Wastewater Flow Factor

The average ABWF and GWI over the flow monitoring period were estimated based on the flow data provided by E2. Table 10 summarizes the monitored flows, estimated average ABWF and GWI over the monitoring period by monitoring site.

Table 10: Monitored Flows – Estimated ABWF and GWI by Monitoring Site

Monitoring Site	Estimated Average Winter Water Use (mgd)[a]	Monitored Flows (mgd)			Estimated Average ABWF (mgd)	Estimated Average GWI[b]	
		Average AWF	Min	Max		mgd	gpd/acre[c]
Site 6	0.764	0.801	0.488	1.277	0.742	0.059	300
Site 7	1.018	0.796	0.536	1.218	0.681	0.115	600
Site 8	0.259	0.477	0.098	1.178	0.460	0.017	100

Footnotes:
a. Based on Nov 2000 – February 2001 water use records provided by the City of Milpitas.
b. Assuming that GWI ~ 0.9*(Min – Continuous Flow)
c. Rounded to the nearest 100

The winter water use for Site 8 estimated from the water use records provided by the City of Milpitas is significantly lower than the estimated average base wastewater flow. After verification of the linkage between water records and parcel data, it was estimated that the winter water use number was reliable. It was decided to discard the average flow data for Site 8 in estimating the BWF factors.

The estimated average GWI over the flow monitoring period at Site 6 and 7 is representing more than 10% of the average AWF over the same period. This percentage is above the range of accuracy of the flow monitoring equipment, and groundwater infiltration was anticipated in these areas and the estimated average ABWF is consistent with the average winter water use. Consequently, GWI was accounted for when computing the BWF factor.

The BWF factor associated with this monitoring area (except Site 8) was estimated using the average week ABWF. Table 11 provides the results of this analysis.

Table 11: Estimated BWF Factor by Monitoring Site

Monitoring Site	Reference Period	Average AWF (mgd)	GWI (mgd)	Average ABWF (mgd)	BWF Factor (gpd/acre)[a]	
					w/o LWU[b]	w/ LWU[b]
Site 6	Week	0.823	0.059	0.764	1,400	3,600
	Weekday	0.897	0.059	0.838	1,800	3,900
	Weekend	0.640	0.059	0.581	400	2,700
Site 7	Week	0.789	0.115	0.674	400	3,600
	Weekday	0.830	0.115	0.715	600	3,800
	Weekend	0.740	0.115	0.625	-	3,300

Footnotes:
a. Rounded to the nearest 100
b. LWU: Large Water Users

Based on the analysis results, the industrial LWU could be modeled with a unit BWF factor as opposed to point sources, as they represent most of the flow in the industrial land use category. However, by doing so the effect of a large water user discharge on the capacity needs of the downstream sewers might be overlooked. Therefore, it was decided to keep the industrial LWU separate for the purpose of this Master Plan.

Based on the analysis results and typical BWF factor for industrial areas, it is recommended to perform a sensitivity analysis using a BWF factor for INDP ranging between 1,000 – 1,800 gpd/acre and 400 – 1,000 gpd/acre for weekday and weekend, respectively; and a BWF factor for IND ranging between 600 – 1,000 gpd/acre and 0 – 600 gpd/acre for weekday and weekend, respectively. The purpose of the sensitivity analysis will be to refine the BWF factors by computing the average dry weather flow for all of Milpitas and comparing it to the actual metered flow at the main lift station during the monitoring period.

Diurnal Flow Pattern

Average weekday and weekend diurnal flow patterns (i.e. hourly flow to average flow ratio versus hour) were created based on the hourly flow data. When appropriate, the groundwater infiltration component was subtracted from the hourly flow to establish the diurnal flow patterns. Figures 5 and 6 illustrate the resulting diurnal flow patterns for weekday and weekend, respectively.

The diurnal flow patterns for Sites 6, 7 and 8 follow a typical diurnal flow pattern for industrial land use, with a "peak" period between 8:00 am – 5:00 pm. The diurnal flow is consistently peaking between 1.1 – 1.2. It should be noted that some industries in the Site 8 monitored area have on-site pre-treatment. Site 8's "atypical" flow variations are likely due to some sort of batch treatment process at one industrial site.

It is recommended to use the average weekday and weekend diurnal flow patterns from Site 6 and 7 for industrial land use.

Conclusions and Recommendations

The ultimate goal of the dry weather flow monitoring was to update the BWF flow factors used for the City's 1994 Sewer Master Plan Update and establish diurnal flow patterns for different types of land use.

Table 12 summarizes the recommended BWF flow factors and diurnal flow patterns associated with five land use categories (SFL, SFM, CMRL, IND and INDP) that were established based on the dry weather flow monitoring data. The recommended diurnal flow patterns for weekday and weekend are shown in Figures 7 and 8, respectively.

Most of the unit BWF factor associated with existing land use categories that were not represented by the dry weather flow monitoring were extrapolated from the established unit BWF factors (see discussions in previous sections). Diurnal flow patterns for these categories were chosen from the set of established diurnal flow patterns based on anticipated similarities in flow generation hourly variations. Table 12 shows the suggested unit BWF factors and diurnal flow patterns.

Unit BWF factors associated with large hotels and schools were estimated from winter water use records provided by the City. Diurnal flow patterns for these categories were chosen from the set of established diurnal flow patterns based on anticipated similarities in flow generation hourly variations. Table 12 shows the suggested unit BWF factors and diurnal flow patterns.

The appropriateness of the estimated unit BWF factors and diurnal flow patterns will be verified/refined by:

- Computing the average BWF flow for all of Milpitas and comparing it to the actual metered flow at the Main PS
- Computing the average BWF flow generation per land use category and comparing it to the winter water use
- Running the hydraulic model and comparing calculated hourly flow with metered flow at several locations in the system

A difference less than 10%, i.e. within the range of accuracy of the flow monitoring equipment and the land use estimates, should be pursued. The appropriateness of the diurnal flow patterns will need to be verified by running the computer model for a 24-hour period and comparing the resulting hydrographs with actual metered flows. A difference less than 10 – 20% should be pursued in calibrating the peak flow.

Verifying and refining the unit BWF factors and diurnal flow patterns was outside the scope of this TM and will be performed later.

Table 12: Recommended Unit BWF Factors and Diurnal Flow Patterns by Land Use Category[a]

Land Use Category	Code	BWF Generation per Person			BWF Generation per Acre		
		Unit BWF Factor (gpd/person)		Diurnal Flow Pattern	Unit BWF Factor (gpd/acre)		Diurnal Flow Pattern
		Weekday	Weekend		Weekday	Weekend	
Valley Floor Residential							
Single-Family Low	SFL	50-70	50-70	Res_av13	NA	NA	NA
Single-Family Medium	SFM	50-70	50-70	Res_av13	NA	NA	NA
Multifamily Medium	MFM	50-70	50-70	Res_site4	NA	NA	NA
Multifamily High	MFH	50-70	50-70	Res_site4	NA	NA	NA
Mobile Home Park	MHP	50-70	50-70	Res_av13	NA	NA	NA
Hillside Residential							
Single-Family Very Low	HVL	70-100	70-100	Res_site4	NA	NA	NA
Single-Family Low	HL	70-100	70-100	Res_site4	NA	NA	NA
Single-Family Medium	HM	70-100	70-100	Res_site4	NA	NA	NA
Commercial							
Town Center	TC	NA	NA	NA	1,700-3,100	1,700-3,100	Com_general
Retail Sub-center	RSC	NA	NA	NA	700-1,300	700-1,300	Com_general
General Commercial	CMRL	NA	NA	NA	1,000-1,800	1,000-1,800	Com_Site5, Com_general
Professional/Administrative Offices	PAO	NA	NA	NA	1,000-1,800	1,000-1,800	Com_General
Industrial							
Industrial Park	INDP	NA	NA	NA	1,000-1,800	400-1,000	Ind_av67
Manufacturing/Warehousing	IND	NA	NA	NA	600-1,000	0-600	Ind_av67
Other							
Large Water Use	LWU	NA	NA	NA	90% of average winter water use		Depends on LWU type
Large Hotel	Hotel	100	100	RES_AV13	NA	NA	NA
Public/Semi-public	CVC	NA	NA	NA	500	500	Com_general
Schools	SCHL	10	10	RES_AV13	NA	NA	NA

Notes:

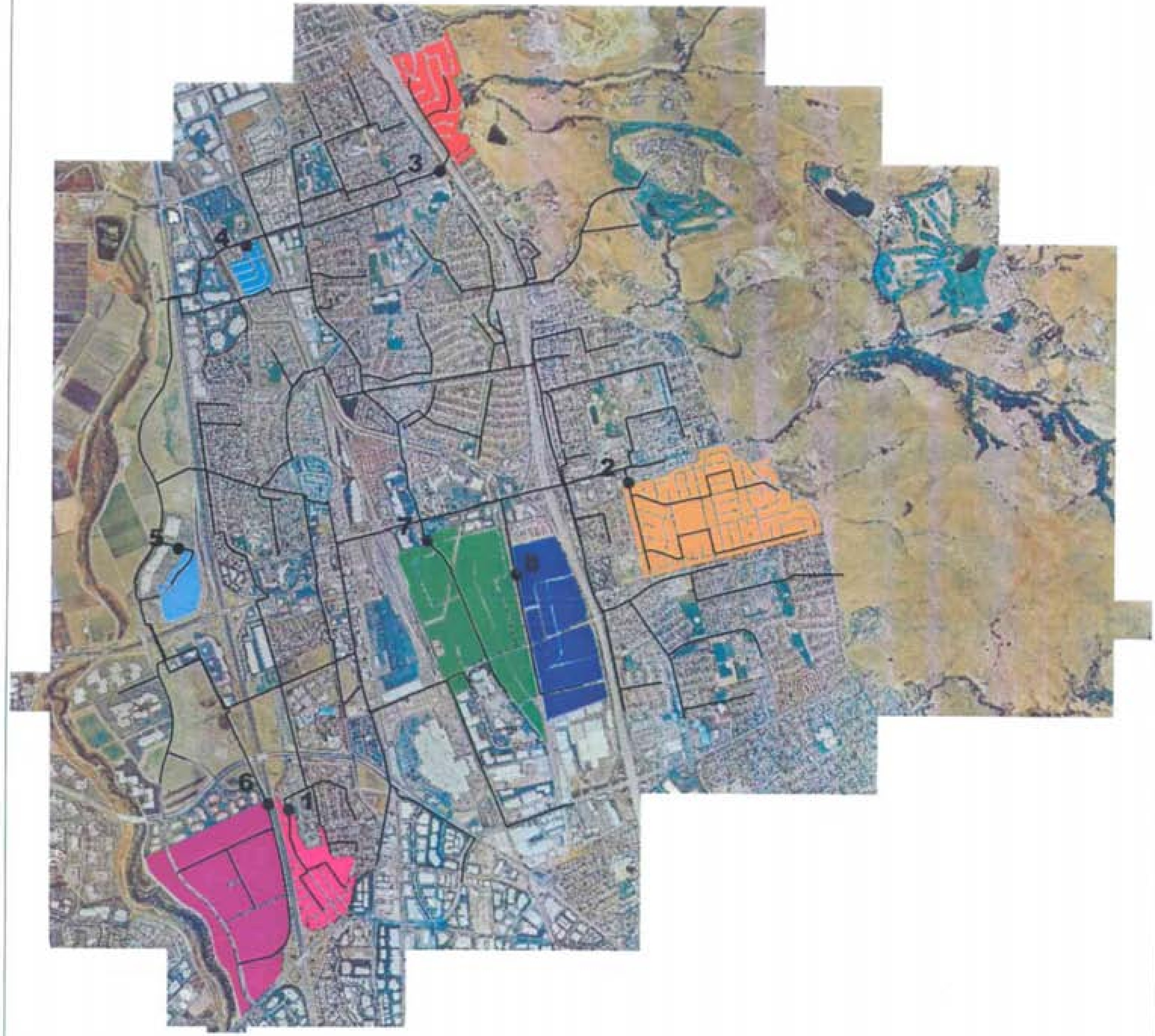
1. Land use categories that are highlighted are the land use categories for which flow monitoring was conducted under 2001 dry weather flow monitoring program.

Footnotes:

a. To be refined through model calibration

APPENDIX C

WET WEATHER FLOW MONITORING TM (2002)



Map 1
Dry Weather Flow Monitoring Sites

City of Milpitas
Sewer Master Plan

N

0 0.3 0.6 Miles

Figure 1: Diurnal Flow Patterns - Weekday

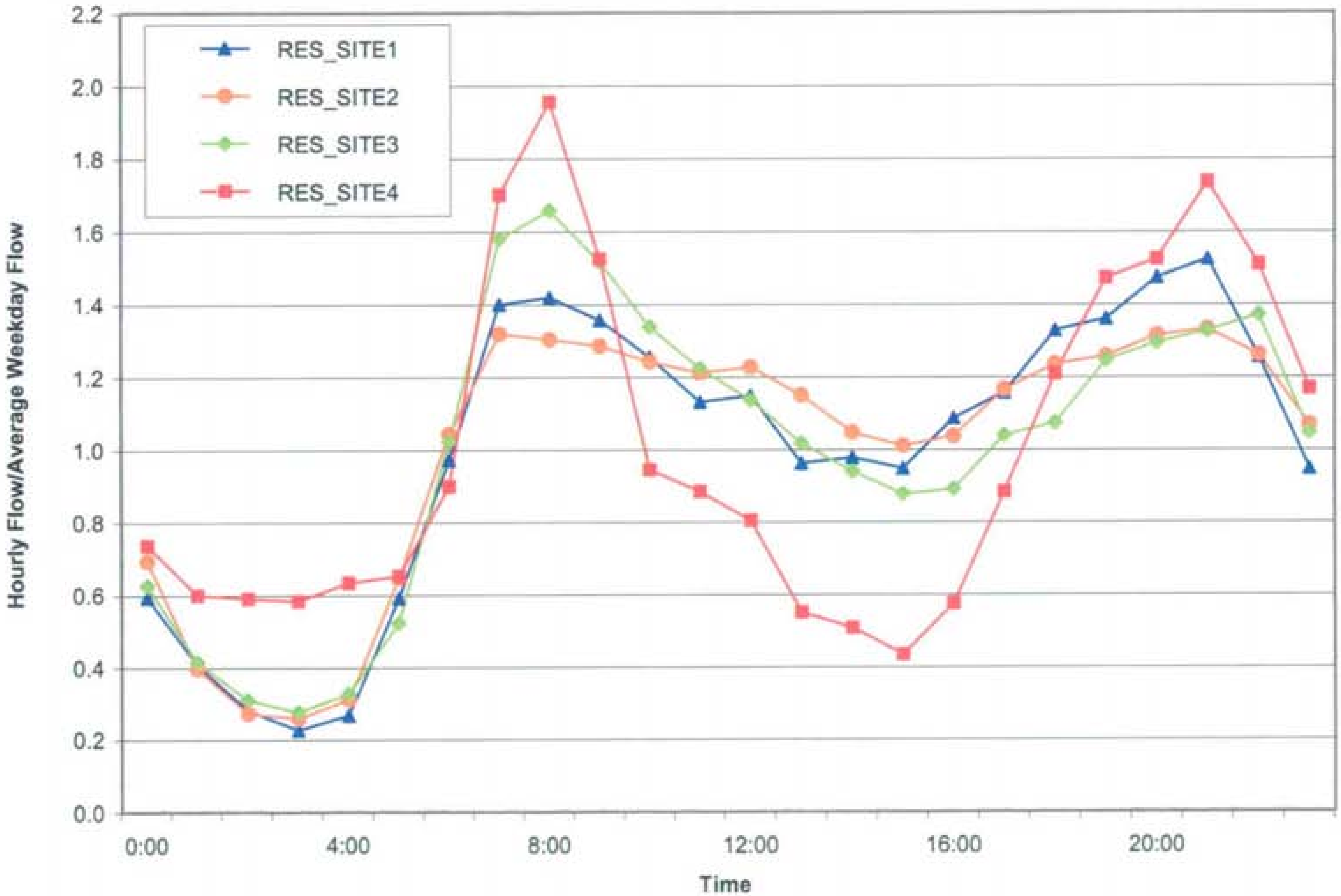


Figure 2: Diurnal Flow Patterns - Weekend

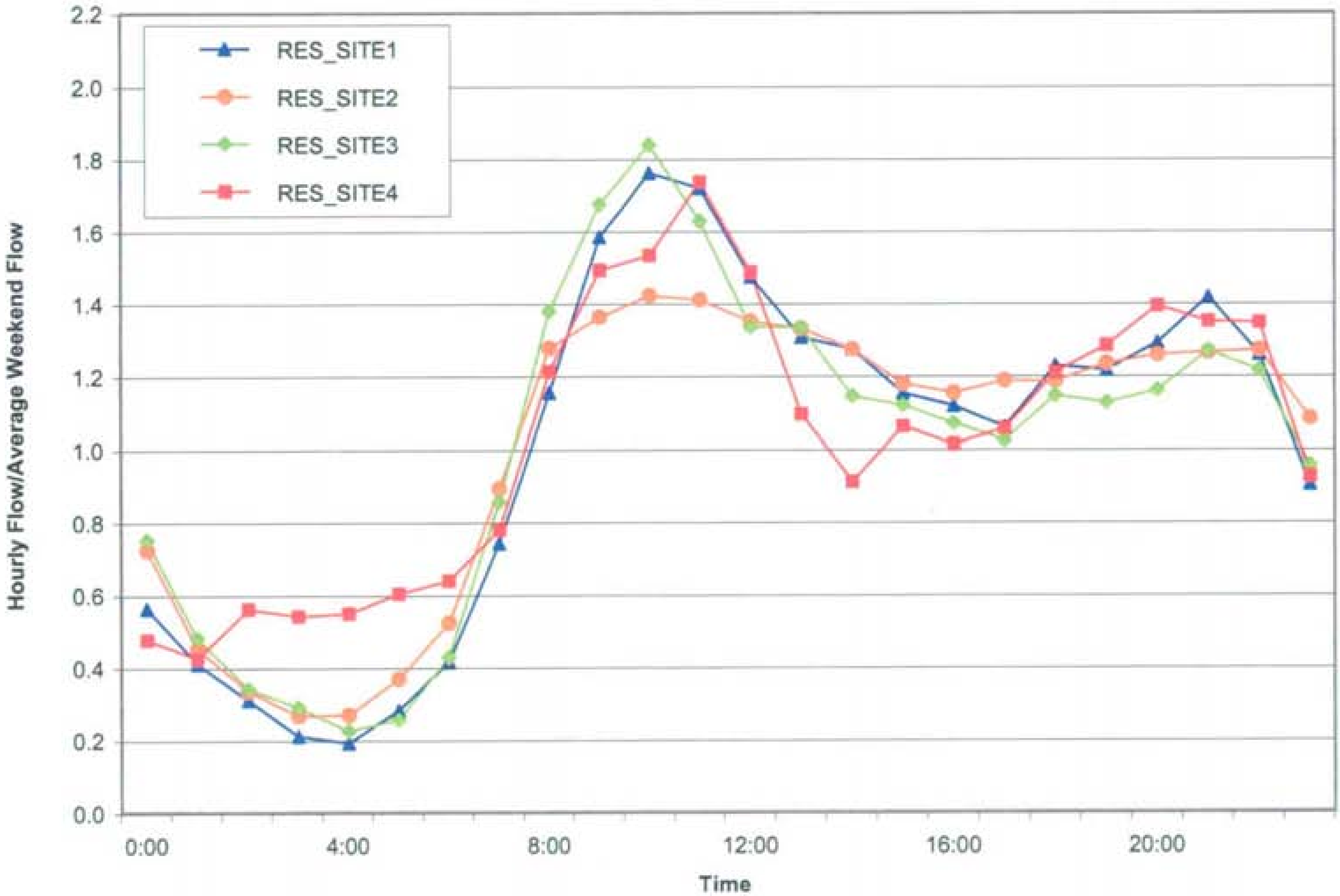


Figure 3: Diurnal Flow Patterns - Weekday

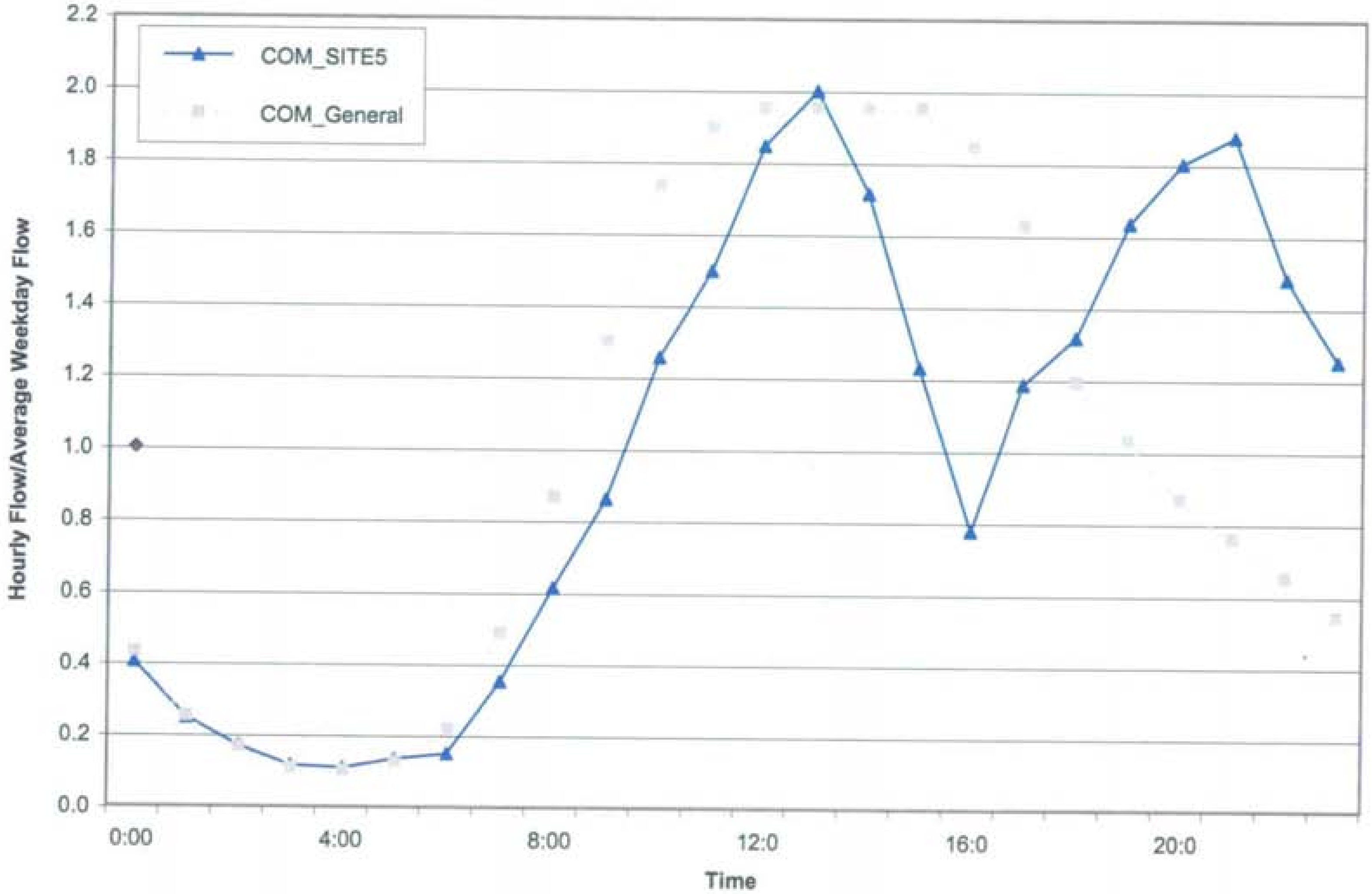


Figure 4: Diurnal Flow Patterns - Weekend

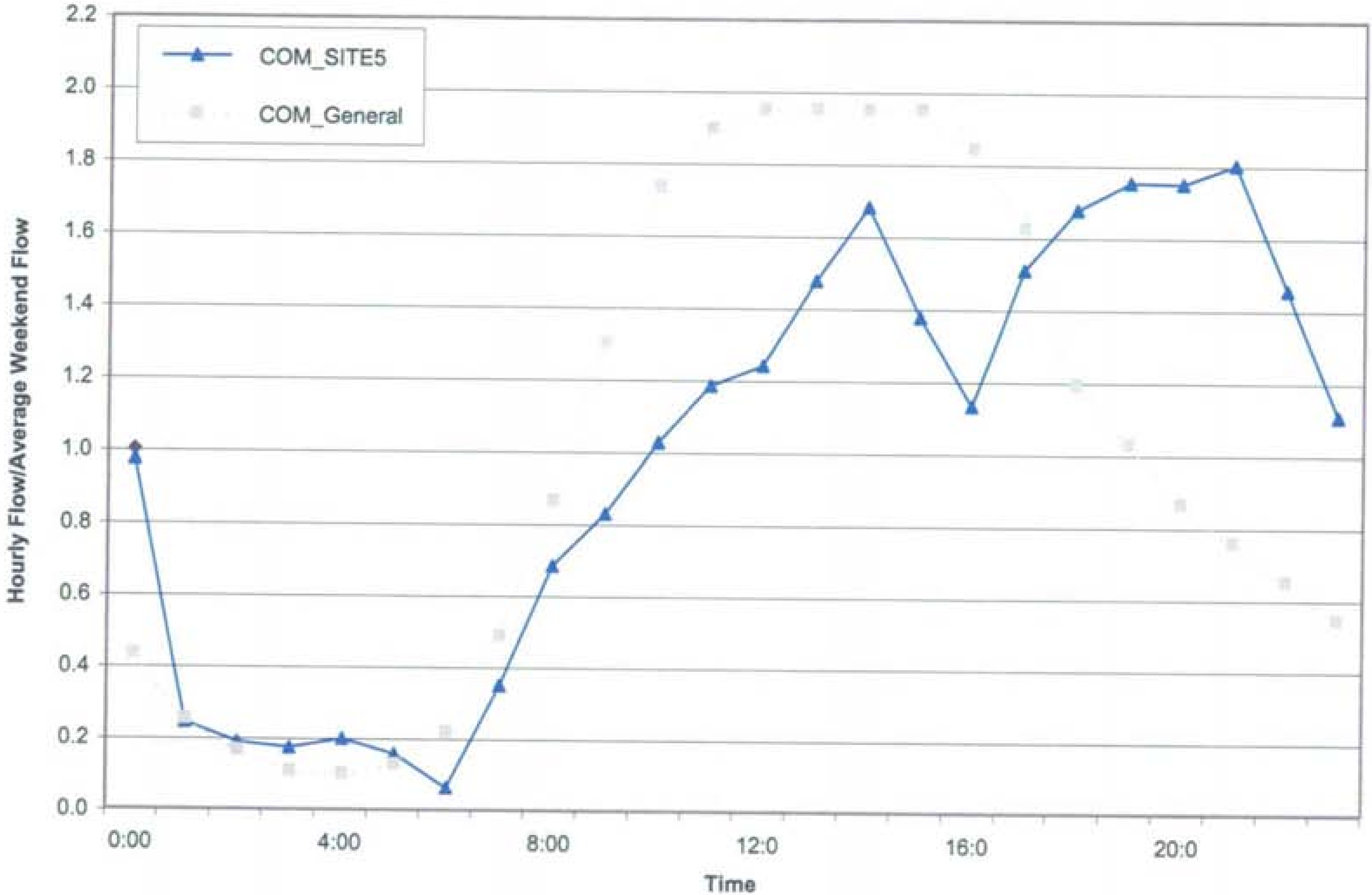


Figure 5: Diurnal Flow Patterns - Weekday

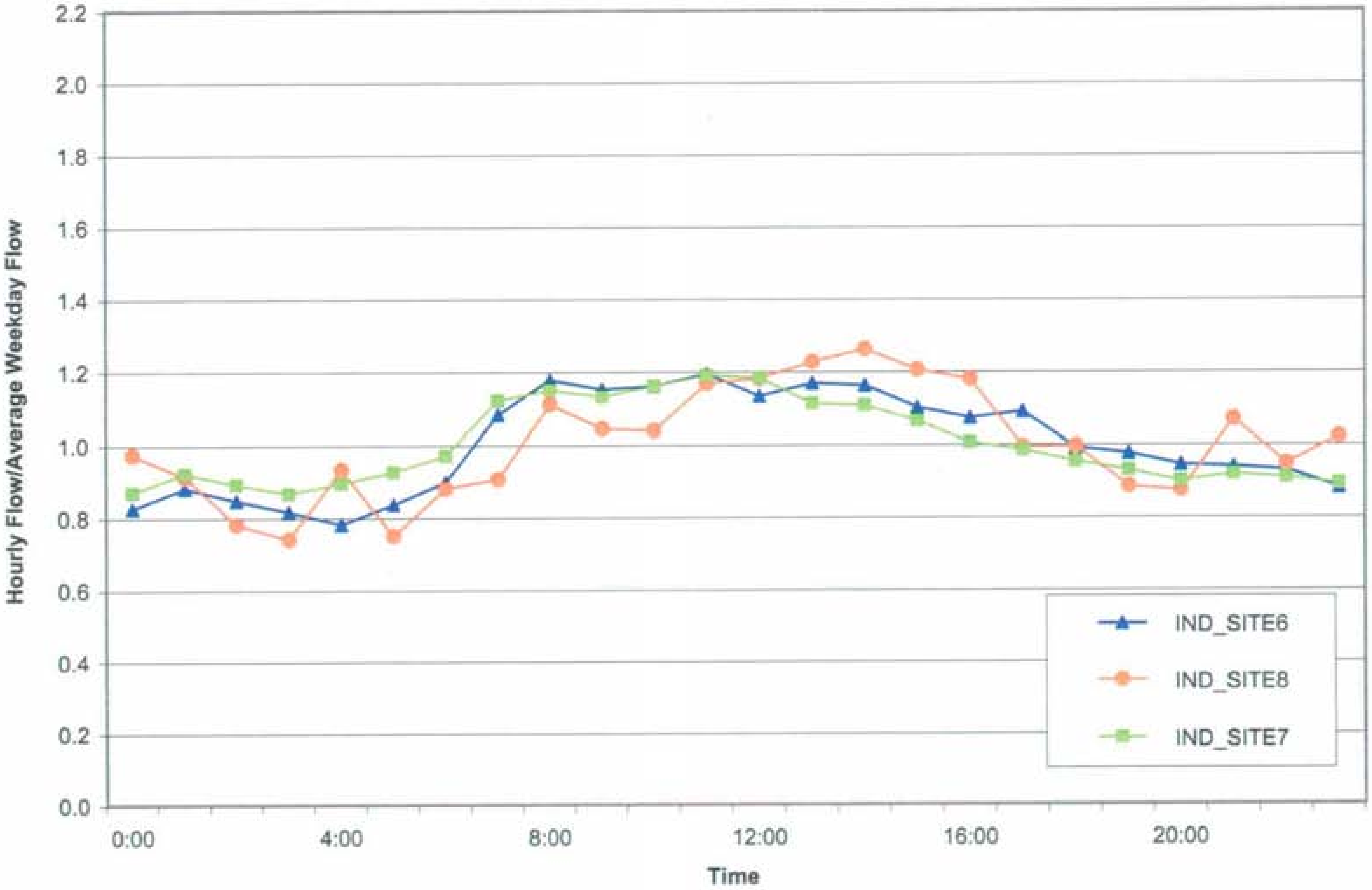


Figure 6: Diurnal Flow Patterns - Weekend

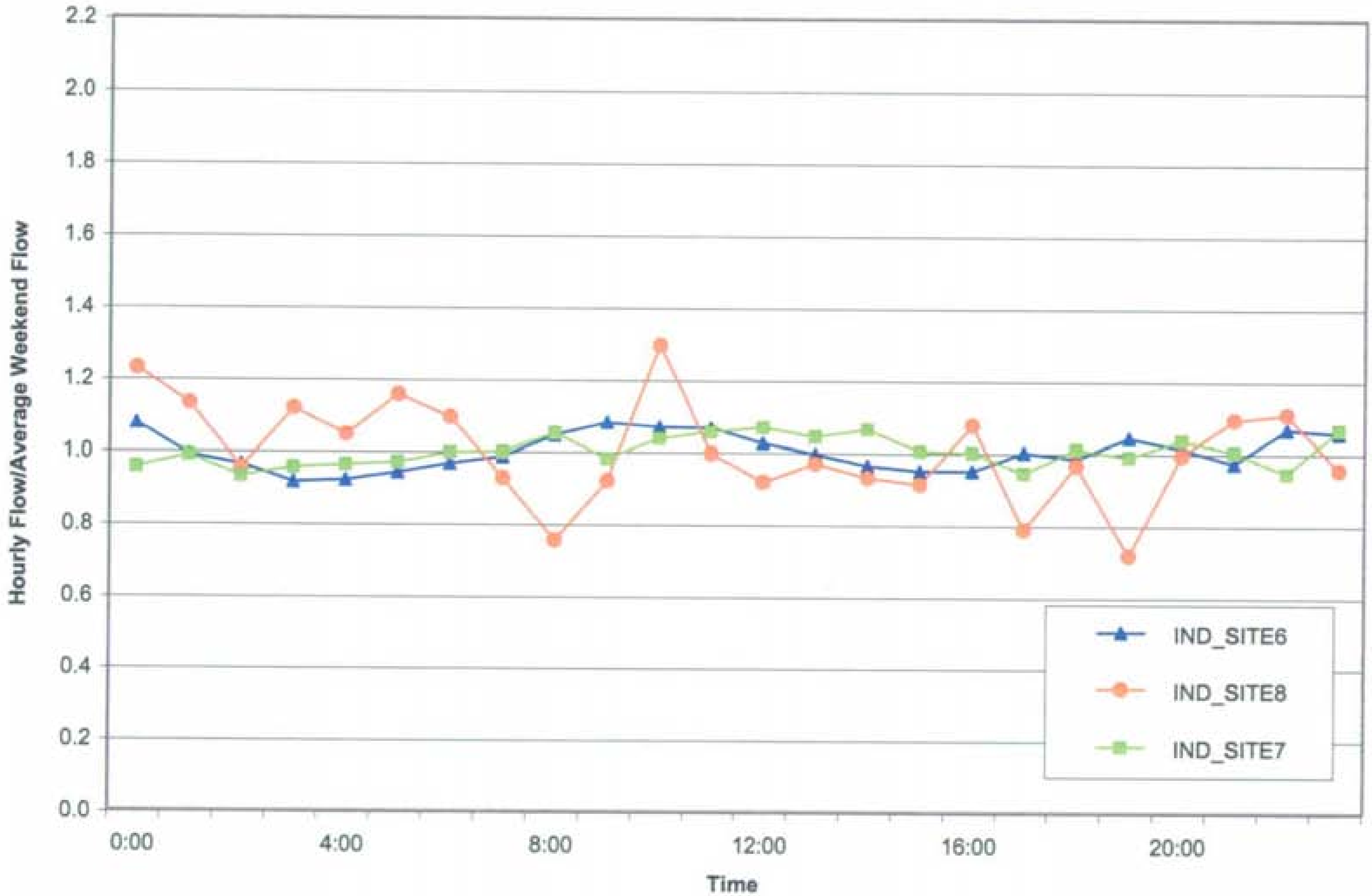


Figure 7: Recommended Diurnal Flow Patterns - Weekday

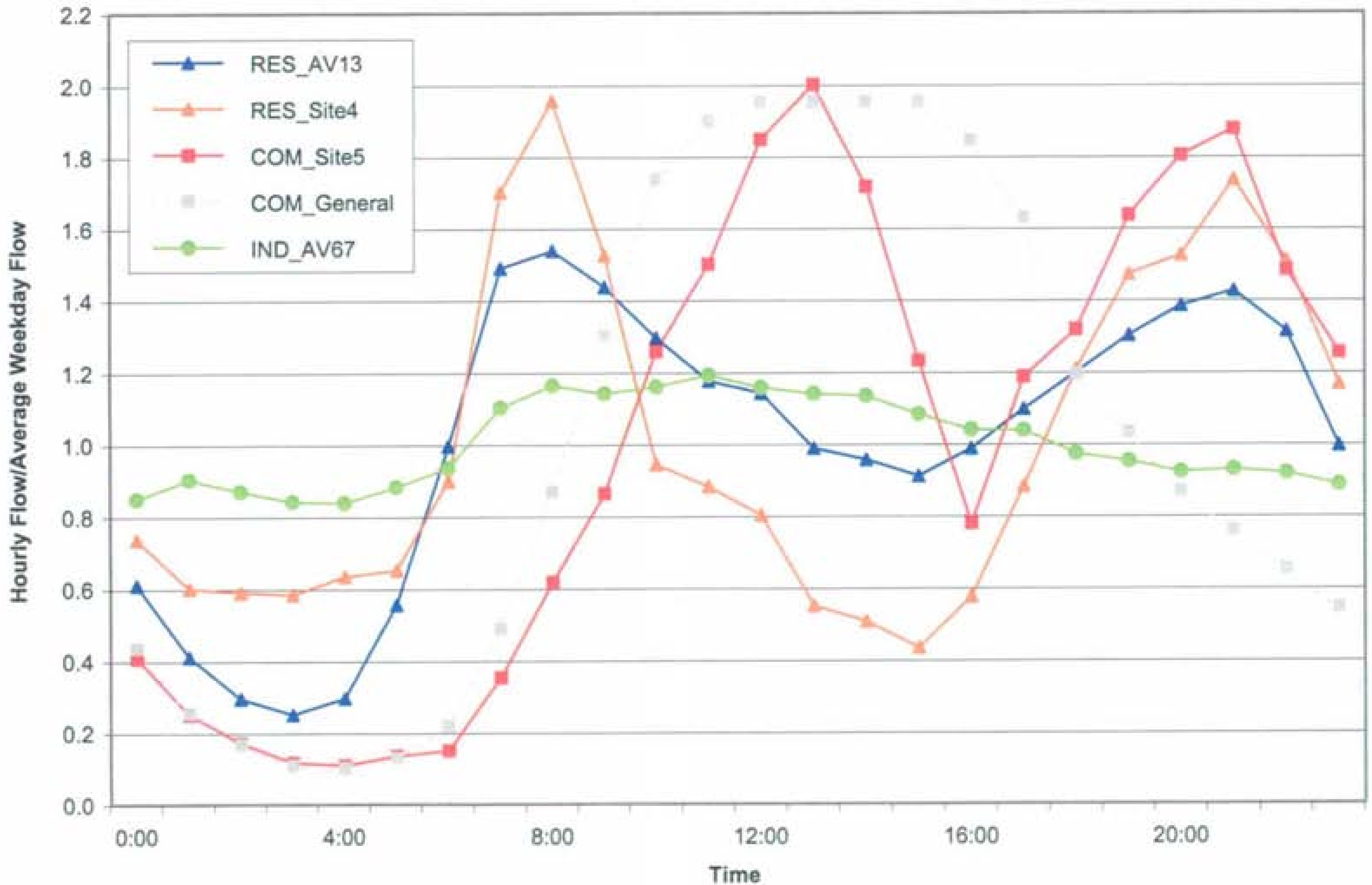
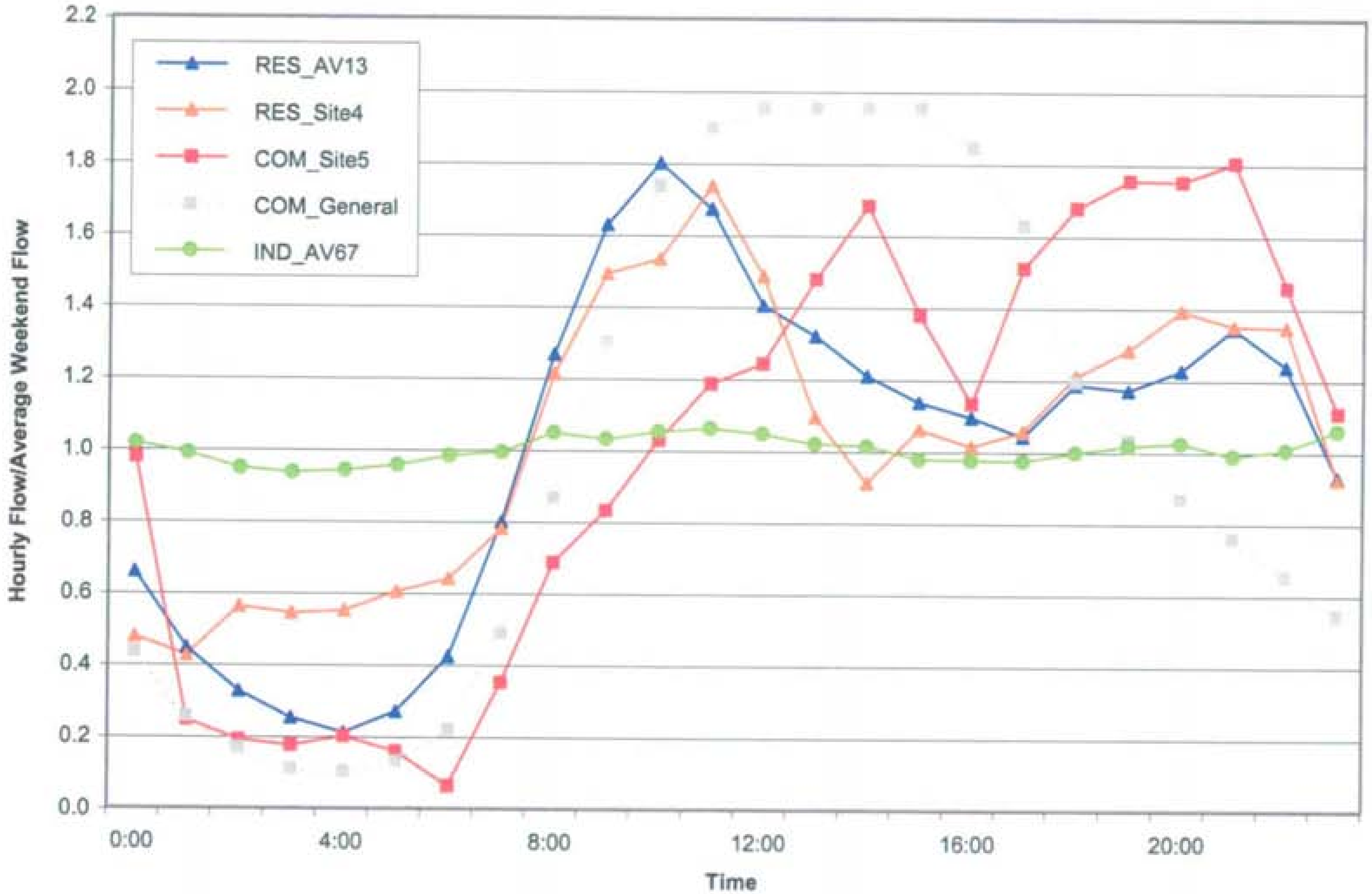


Figure 8: Recommended Diurnal Flow Patterns - Weekend



ATTACHMENT A

Dry Weather Flow Monitoring – Summer 2001

Conducted by E2 Consulting Engineers, Inc.

(See attached CD-Rom)

Technical Memorandum

City of Milpitas – Sewer Master Plan

Subject:	Wet Weather Wastewater Flow Monitoring
Prepared For:	Aparna Chatterjee
Prepared By:	Helene Kubler
Reviewed By:	Justine Faisst Tom Richardson
CC:	File, Darryl Wong, Marilyn Nickel
Date:	June 2002 (DRAFT) December 2002 (FINAL)
Reference:	051.0060

Wet weather wastewater flow data is key to developing a reliable, dynamic computer model of the collection system, which will be the basis for identifying necessary improvement projects and developing a capital improvement program for the City of Milpitas Sewer Master Plan.

The purpose of the 2002 wet weather wastewater flow monitoring program was to collect the data necessary to perform the following tasks:

- Estimate groundwater infiltration (GWI) and rainfall-dependent infiltration/inflow (RDI/I) components of the wastewater flow for representative sewer basins for input into the hydraulic model; and,
- Calibrate the dynamic hydraulic model for existing conditions (as of June 2001).

This Technical Memorandum (TM) presents the results of the wet weather wastewater flow data analysis, including the estimate of the groundwater infiltration and rainfall-dependent infiltration and inflow components. Hydraulic model calibration (i.e. running the hydraulic model to validate/calibrate the estimated base flow production, GWI and RDI/I components of the wastewater flow, using wet weather, downstream flow data) is outside the scope of this TM and will be performed later. This TM does NOT discuss design GWI and RDI/I rates. Design rates and design storm will be discussed with the City staff after the model is calibrated.

The TM is organized as follows:

Note: All maps can be found at the end of the TM.

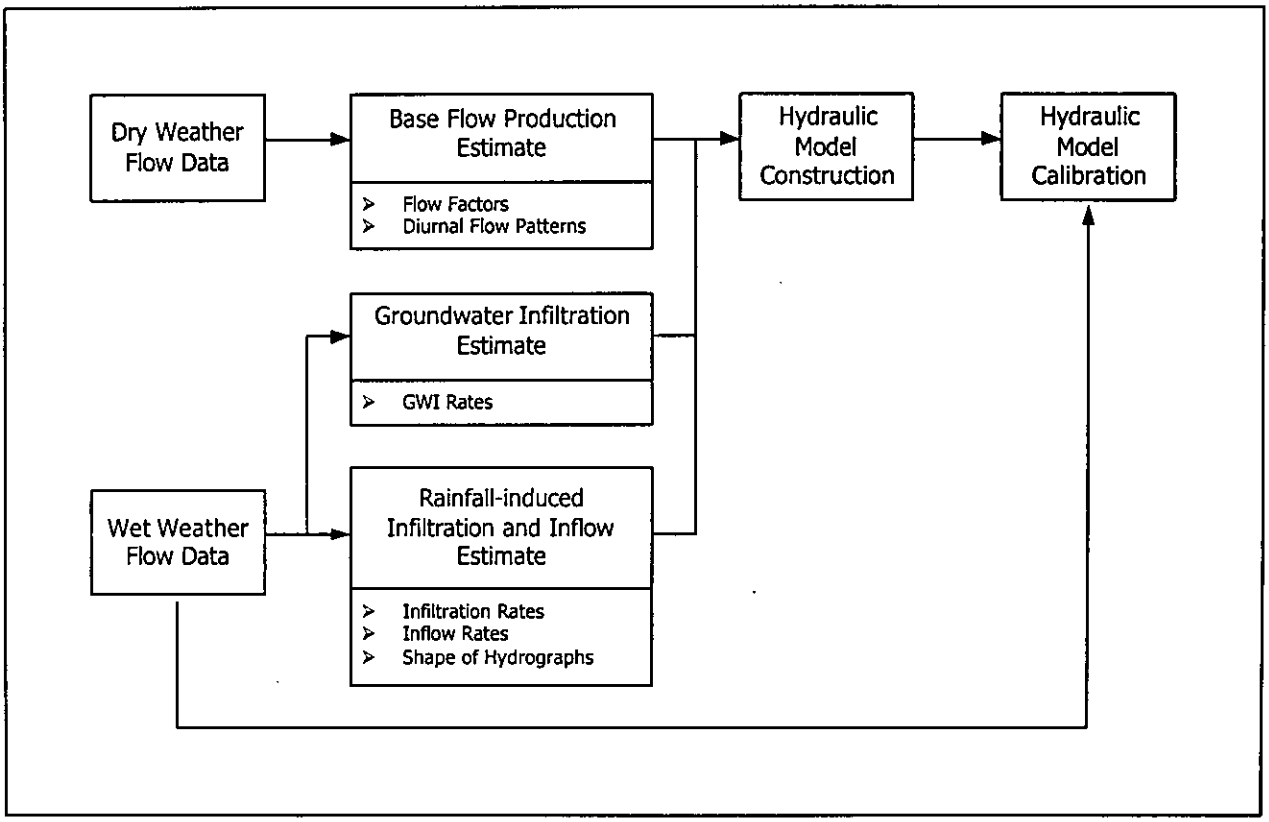
References:

Dry Weather Wastewater Flow Monitoring Technical Memorandum – Draft (RMC, October 2001)
Existing and Future Land Use Estimates Technical Memorandum – Draft (RMC, September 2001)
Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 1999)
City of Milpitas Sewer Master Plan Update (Carollo Engineers, June 1994)
City of Milpitas Sewer System Master Plan (CH2M Hill, November 1984)
Intensive Flow Evaluation (CH2M Hill, November 1984)

Introduction

Modeling the City collection system under wet weather wastewater flow conditions is required to determine the capacity needs of the system and identify necessary capacity improvement projects. The reliability of the dynamic model (HYDRA) depends to a large extent on the appropriateness of the wet weather wastewater flow input in the model and calibration work. As shown on Figure 1, wet weather flow data is key to estimating GWI and RDI/I components of the wastewater flow and perform calibration work.

Figure 1: Flow Data Integration and Use in HYDRA



As part of the 2001 dry weather flow monitoring program (RMC, October 2001), flow factors and diurnal flow patterns were updated/developed and input in the hydraulic model to estimate the base flow production component of the wastewater flow. The next phase of work is to 1) estimate and input the GWI[1] and RDI/I[2] components of the wastewater flow under saturated soil conditions (worse case scenario), and 2) calibrate the model for existing conditions (as of June 2001).

[1] Groundwater infiltration (groundwater flow that enters the system consistently, 24 hours a day) is modeled in Hydra by inputting constant groundwater infiltration rates associated with different sewer basins or specific area of the system (e.g. old sewers, invert below groundwater table). GWI might vary hourly in Milpitas due to tidal influence. However, for the purpose of the Sewer Master Plan, this potential hourly fluctuation will not be represented in the model.
[2] Rainfall-dependent infiltration and inflow is modeled in Hydra by inputting the infiltration and inflow rates (both as a percent of the total rainfall volume) and the basic shape of the hydrograph, which differs from the shape of the hyetograph due to the delays caused by the percolation process, associated with different sewer basins.

Existing Information

Existing information on GWI and RDI/I and available calibration data are discussed below.

Groundwater Infiltration

Kennedy/Jenks Consultants conducted the most recent groundwater infiltration evaluation, in 1999. This study looked at the GWI in the system during the dry season. Infiltration, estimated at 1.3 mgd, was found to occur mostly from household laterals, with some small contribution from manholes in the valley floor, primarily in the areas where the groundwater level exceeds the sewer invert elevation. The 2001 dry weather flow monitoring program (RMC, October 2001) also evaluated GWI, but in the metered areas only. However, for the purpose of the Sewer Master Plan, maximum GWI, which is usually observed under saturated soil conditions, must be evaluated.

The only source of information on GWI under saturated flow conditions is the Intensive Flow Evaluation, conducted by CH2M Hill in 1984 and used as part of the 1994 Sewer Master Plan. The design GWI rates by sewer basin established in the Intensive Flow Evaluation are appended in Attachment A for reference. Estimated GWI totaled 1.39 million gallons per day (mgd), i.e. 240 gallons per acre per day (gpad) on average assuming a total sewered area in 1984 of 5,770 acres. The existing sewered area (as of June 2001) is approximately 6,000 acres. Most of the acreage developed since 1984 has been developed west of I-880. Based on input from Public Works department staff, some of the new pipes in this area are in the worse condition due to high groundwater levels and might present high GWI. In addition, a pipe rehabilitation/replacement program was completed in 1987. GWI might have decreased in rehabilitated area while increasing in areas where no rehabilitation work was performed and presenting old sewers with inverts below the groundwater table.

Additional wet weather data was, therefore, necessary to establish GWI rates for input in the hydraulic model.

Rainfall-induced Infiltration and Inflow

Carollo Engineers conducted the most recent wet weather flow monitoring (1991) as part of the 1994 Sewer Master Plan Update. The previous wet weather flow monitoring program was conducted in 1983 as part of an Intensive Flow Evaluation (CH2M Hill, November 1984).

Using the calculated RDI/I rates established in these studies was not recommended, for the following reasons:

- Unsaturated soil condition and/or "insufficient" rainfall occurred during both flow monitoring programs;
- The data is old and likely do not represent existing conditions;
- Rehabilitation work may or may not have reduced RDI/I; and,
- Some inconsistencies in the data analysis were identified when comparing the Intensive Flow Evaluation, 1984 Sewer Master Plan and 1994 Sewer Master Plan. These inconsistencies resulted in significantly overestimated RDI/I flows in the Master Plans (e.g., a total of 12.7 mgd of RDI/I was calculated for the 10-year design storm in the Intensive Flow Evaluation, but a total of 24.9 mgd of RDI/I was assumed for the same storm in the 1984 Sewer Master Plan). The design RDI/I rates by sewer basin established in the Intensive Flow Evaluation are appended in Attachment A for reference.

In addition, no hydrograph was defined and used as part of the 1984 and 1994 Sewer Master Plans since the static model did not require such information. The RDI/I rates used in these studies are <u>peak hour</u> rates.

Additional wet weather data would, therefore, help estimating RDI/I rates and establishing the basis of the hydrograph for input in the hydraulic model.

Hydraulic Model Calibration

None of the meters installed at the main lift station provides the hourly flow data necessary to calibrate the dynamic hydraulic model. In addition, downstream flows were not metered as part of the 2001 flow monitoring program. Metering downstream flows is therefore required to calibrate the model (including validate/calibrate estimated base flow production components derived from the 2001 dry weather flow monitoring program).

Purpose

The purpose of the 2002 wet weather flow monitoring program was to collect the data necessary to perform the following tasks:

- Estimate the GWI rates under saturated soil conditions, associated with specific areas of the system (e.g., old sewers, invert below groundwater table), for input in the hydraulic model;
- Estimate the RDI/I rates, and infiltration hydrograph under saturated soil conditions associated with different sewer basins, for input in the hydraulic model; and,
- Calibrate the dynamic hydraulic model (including validate/calibrate estimated base flow production components derived from the 2001 dry weather flow monitoring program).

Flow Monitoring Program

The City of Milpitas 2002 wet weather flow monitoring program consisted of twelve temporary flow meters installed for a two-month period. The following sections describe the different tasks that were involved as part of the flow monitoring program.

Period Selection

As discussed in the introduction, existing I/I could not be established in the 1994 master plan due to unsaturated soil condition and/or "insufficient" rainfall (0.6"on 12/10/90, 0.79" on 12/15/91, and 0.99" on 2/4/91) during the 1990/91 flow monitoring program.

The flow monitoring program should meet the following criteria to produce good, exploitable data:

- The soil should be saturated during the flow monitoring period.
- A minimum of three discrete, "significant" rain events (total rainfall exceeding 0.75 inches) should be monitored.

Ideally, wet weather flow monitoring would be performed throughout the rainy season (November – February) to maximize the chance of meeting the aforementioned criteria. Due to budget limitations, the City and RMC agreed upon a one- to two-month monitoring period.

Based on historical rainfall, February was considered the best period for flow monitoring since January rains usually saturate the ground and February is historically the wettest month in the year (based on historical rainfall data obtained from the California Irrigation Management Information System at station #69 in San Jose). Flow monitoring was, therefore, scheduled to start by the end of January 2002 and last through February 2002. The one-month period was extended to two months due to the lack of significant rainfall events in February. The program was stopped on March 27, as the chance of a major storm event occurring in April was very low. The actual lack of significant rainfall during the entire monitoring period is further discussed in the Flow Data Analysis section.

Site selection

An adequate number of flow meters should be installed at adequate sites to produce good, exploitable data.

Ideally, wastewater flows from each of the sewer basins should be measured separately. Due to the scope of the study and budget limitations, twelve monitoring stations were selected to provide minimum information for estimating the I/I rates and calibrating the model.

The site selection included a number of factors such past flow monitoring effort (ten flow monitoring sites were selected for the 1990/91 flow monitoring program), City input regarding potential areas of high I/I, the age of the sewers, sewer basins, and the absence of junctions and flow splits at the manholes to minimize measurement error.

Information used to locate manholes throughout the City where meaningful data could be collected was gathered from the following sources:

- Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 1999), including a map of the area where the average groundwater elevation is above the sewer inverts;
- Sewer System 1"=100' Maps provided by the City of Milpitas;
- Map of age of the sewers provided by the City of Milpitas; and
- Discussions with the Public Works Department staff.

Discussions with the Public Works Department staff provided the following information:

- The flow meter at the main lift station may not reflect the total flows;
- The age of the sewer should not be used exclusively as a criterion to determine areas of potential high I/I since some of the newest pipes west of Highway 880 are in the worse condition;
- The Hidden Lake Park area is an area of high groundwater. There are frequent surcharge problems on the 15" sewer line between Strickroth Dr and the connection between North Milpitas Blvd 39" sewer line.

Table 1 summarizes information relevant to the monitored manholes. Map 1 shows the location of the flow monitoring sites and the corresponding sewered area. Map 2 shows the age of the sewers and area where the average groundwater elevation is above the sewers invert.

Table 1: Wet Weather Flow Monitoring Sites

	Manhole #[a]	Location	Pipe Size (Inches)	Sewered Area (acres)	Potential GWI	Potential I/I
1	15-4-02[b]	California Circle	18	500	Medium	Medium
2	30-5-09	Tramway Dr between Singley Dr and Strickroth Dr	12	90	High	High
3	43-2-17	Hillview Dr between Jacklin Rd and Del Vaile Ct	18	600	Low	Medium
4	18-2-22	Baker St at Norwich Av cross-section	10	60	High	High
5	46-1-01	Milpitas Blvd between Los Coches St and Calaveras Blvd	18	200	Medium	Low
6	58-5-01[b]	Dempsey Rd between Yosemite Dr and Edsel Dr	21	530	Low	High
7	35-2-01[b]	Main St between Curtis Av and Siphon under Hetch Hetchy aqueduct	18	550	Medium	Low
8	21-5-01	Barber Ln between Tasman Dr and siphon under Hetch Hetchy aqueduct	24	250	Medium	Low

	Manhole #[a]	Location	Pipe Size (Inches)	Sewered Area (acres)	Potential GWI	Potential I/I
9	22-3-05	Starlite Dr at Galaxy Ct cross-section	8	60	High	High
10	16-1-02[b]	California Circle at Cadillac Ct cross-section	42	Flow records will serve for total downstream flow calibration		
11	18-1-03[c]	Between Highway 880 and McCarthy Blvd	30	Flow records will serve for total downstream flow calibration		
12	7-3-03	McCarthy Blvd between Ranch Dr and 30" sewer connection	36	Flow records will serve for total downstream flow calibration		

Notes:

1. Estimates for potential GWI and I/I are based on map of age of sewers provided by the City, critical areas identified by Public Works Department staff, and map of average groundwater level (Kennedy/Jenks Consultants, October 1999).

Footnotes:

a. Refers to the City of Milpitas Sewer System Nodal Map. The first two numbers correspond to the sheet number and quadrangle, respectively, in the City's Sewer System 1"=100' Maps.
b. These manholes were successfully monitored between November 1990 and February 1991 (Carollo Engineers, June 1994).
c. This is not the manhole that was metered, but it is the closest manhole shown on the City of Milpitas Sewer System Nodal Map.

Sites 1 through 9 were selected to evaluate the GWI and RDI/I components of the wastewater flows associated with representative sewer basins. A total of 2,840 acres (i.e., approximately 45% of the entire sewered area) were metered at these sites. Sites 1, 10, 11 and 12 were specifically selected to calibrate the total downstream flow, as the meter at the main lift station does not provide hourly flow data necessary for calibrating the dynamic model. Sites 5 and 9 were also monitored as part of the 2001 dry weather flow monitoring program. The dry and wet weather wastewater flow data for these sites can be compared to identify potential changes in groundwater infiltration under unsaturated and saturated soil conditions.

Two rain gages were installed for the duration of the flow monitoring period:

- Rain gage #1 was installed at the Public Works Department, located on North Milpitas Blvd, in the north-central section of the City (Valley Floor area); and,
- Rain gage #2 was installed at the Fire Station #2, located on Yosemite Dr, in the southeast section of the City (near the Hillside area).

Flow Monitoring and Calculation

Prior to installing the flow meters, RMC's subconsultant, E2 Consulting Engineers, inspected all of the monitoring sites to verify access to manholes, assess their suitability for equipment installation, and determine the size of the pipes to be monitored and the most appropriate monitoring equipment to use.

E2 Consulting Engineers conducted the flow monitoring program fieldwork. The program utilized SIGMA 910 flow meters, which record both the depth and velocity of the flow. This data was then processed to calculate the resulting flow rate based on the continuity equation. Meter calibration was accomplished by taking manual measurements of flow depth and velocity in the flow stream. The flow monitoring crew visited the meter sites at least weekly to check the meters, retrieve data and obtain field calibration measurements.

E2 Consulting Engineers performed the flow calculations. E2's flow monitoring report, including field reconnaissance information and flow data plots, is provided in Attachment B.

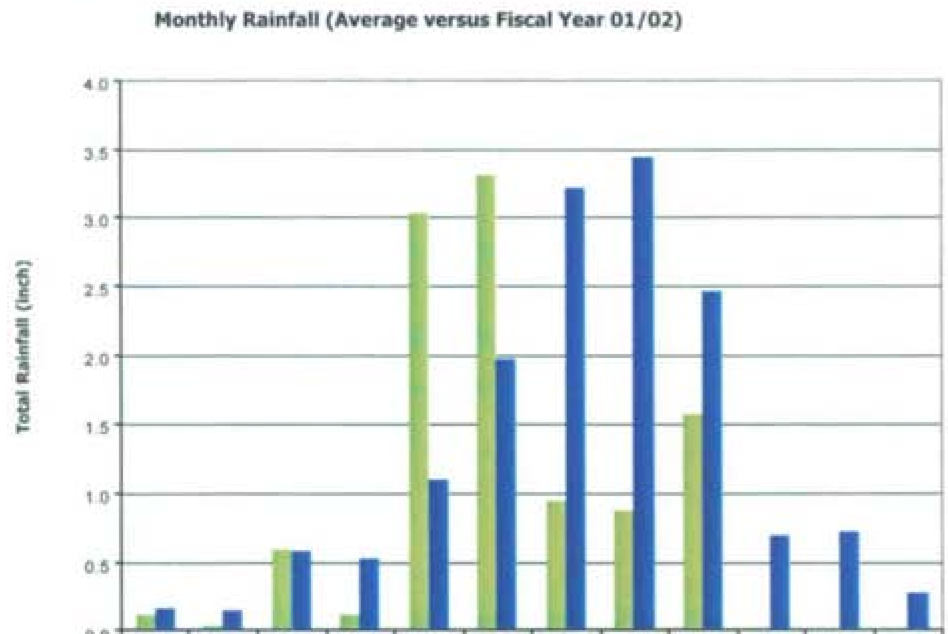
Flow Data Analysis

Due to the lack of significant rainfall during the entire monitoring period (see Rainfall Section), the data necessary to complete the three tasks initially identified could not be collected. The objectives of the flow data analysis had to be revised (see Revised Objectives Section).

Rainfall

A very atypical rainfall pattern was experienced during 2001/2002 rainy season. Figure 2 shows that November and December 2001 were the wettest months of this past rainy season with over 3 inches of rain each month (compared to less than an inch of rain for January and February), while January and February have historically been the wettest months (see Average Rainfall over 1988-2001).

Figure 2: Monthly Rainfall (Average versus Fiscal Year 01/02)



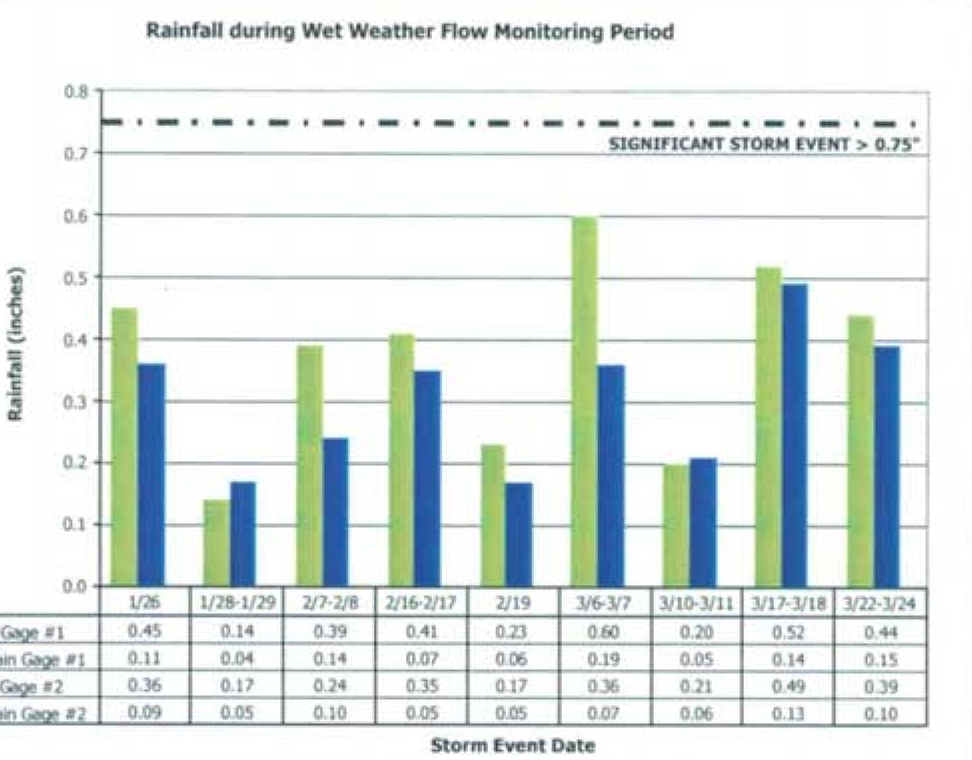
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
FY 01/02	0.12	0.04	0.59	0.12	3.03	3.31	0.94	0.87	1.57			
Average over 1988-2001	0.16	0.15	0.58	0.52	1.10	1.97	3.21	3.44	2.46	0.70	0.71	0.27

Month

Source: California Irrigation Management Information System at station #69 in San Jose (http://www.cimis.water.ca.gov).

Figure 3 shows that none of the nine discrete storm events that occurred during the February-March flow monitoring period was "significant" (total rainfall exceeding 0.75 inches). The two most significant events totaled only 0.60 and 0.52 inches of rain (at rain gage #1).

Figure 3: Rainfall during Wet Weather Flow Monitoring Period



	1/26	1/28-1/29	2/7-2/8	2/16-2/17	2/19	3/6-3/7	3/10-3/11	3/17-3/18	3/22-3/24
Total - Rain Gage #1	0.45	0.14	0.39	0.41	0.23	0.60	0.20	0.52	0.44
Peak Hr - Rain Gage #1	0.11	0.04	0.14	0.07	0.06	0.19	0.05	0.14	0.15
Total - Rain Gage #2	0.36	0.17	0.24	0.35	0.17	0.36	0.21	0.49	0.39
Peak Hr - Rain Gage #2	0.09	0.05	0.10	0.05	0.05	0.07	0.06	0.13	0.10

As a result of the relatively light rainfall, and although the soil was likely saturated by the December storms, there was a quasi-absence of noticeable RDI/I in the system. Only Site 4 flow data showed possible I/I associated with the most significant rain events.

Revised Objectives

Table 2 summarizes the initial versus revised objectives as regards the use of the wet weather flow monitoring data.

Table 2: Initial vs. Revised Objectives of Flow Data Analysis

	Initial Objectives	Revised Objectives
GWI	• Evaluate GWI rates under saturated soil conditions for representative sewer basins [a]	• Unchanged
RDI/I	• Evaluate RDI/I rates and hydrograph under saturated soil conditions for representative sewer basins [a]	• Evaluate RDI/I rates and hydrograph under saturated soil conditions for monitored area 4 [b]
Calibration	• Calibrate total downstream flow [c] and estimated base flow production [a & c]	• Unchanged, except that RDI/I will be difficult to calibrate due to relatively insignificant flow increase during rain events

Footnotes:

a. Based on data at Sites 1 – 9.
b. Based on data at Site 4.
c. Based on data at Sites 1, 10, 11 and 12.

The flow data analysis is summarized in the following sections, addressing separately GWI, RDI/I, and hydraulic model calibration.

Groundwater Infiltration

Table 3 summarizes estimated GWI for metered areas 1 to 9.

Table 3: Estimated GWI for Metered Areas 1 to 9

Site	Average Winter Water Use (mgd) [a]	AWF over Monitoring Period (mgd)	Estimated GWI	
			(mgd)	(gpad)
1	0.98	0.94	0.33 [b]	750 [c]
2	0.22	0.23	0.04	450
3	0.29	0.22	0.08	450 [d]
4	0.10	0.07	0.02	300
5	1.02	0.93	0.22	1100
6	0.90	0.67	0.09	200
7	0.81	1.26	0.60	1100
8	0.81 [e]	0.54	0.05	200
9	0.13	0.09	0.03	450
		Total/Average	**1.46**	**550**

Notes:

1. AWF: average daily wastewater flow; GWI: average daily groundwater infiltration; mgd: million gallons per day; gpad: gallons per acre per day; ABWF: average daily base wastewater flow; Min: minimum flow
2. The following industry-standard relationships were assumed for the flow data analysis:
   AWF = ABWF + GWI
   ABWF ~ 1.25 x (AWF – Min) in residential areas
   GWI ~ 0.9 x (Min – Continuous Flow) in commercial/industrial areas

Footnotes:

a. Estimated based on Nov 2000 – Feb 2001 water use records provided by the City of Milpitas.
b. Minimum flow averaged 0.45 mgd at Site 1, which represents approximately 50% of the average flows. A similar ratio was observed during the 1991 wet weather flow monitoring (Carollo Engineers, June 1994) at this site, which reduces the likelihood of a measurement error. High minimum flows could then be due to 1 relatively high residential wastewater flow at night, 2) high groundwater infiltration, and/or 3) industrial activities at night. Since industrial water use records total only 0.08 mgd and residential wastewater production has not yet been calibrated, it was assumed that night flows are due to groundwater infiltration. This assumption will be validated/revised during model calibration.
c. Based on 2001 dry weather flow monitoring, age of sewers and groundwater elevation in the area, GWI likely occurs only west of I-680. The metered area west of I-680 totals 440 acres.
d. GWI likely occurs only in the Valley floor area. The Valley floor metered area totals 180 acres.
e. Industrial activities in the metered area slowed down due to the economy downturn, reducing flow generation by approximately 0.3 mgd (i.e. approximately 40% of the average flow) between winter of FY 00/01 and FY 01/02. It was assumed that continuous flows were also reduced by 40 %, from 0.55 to 0.33 mgd.

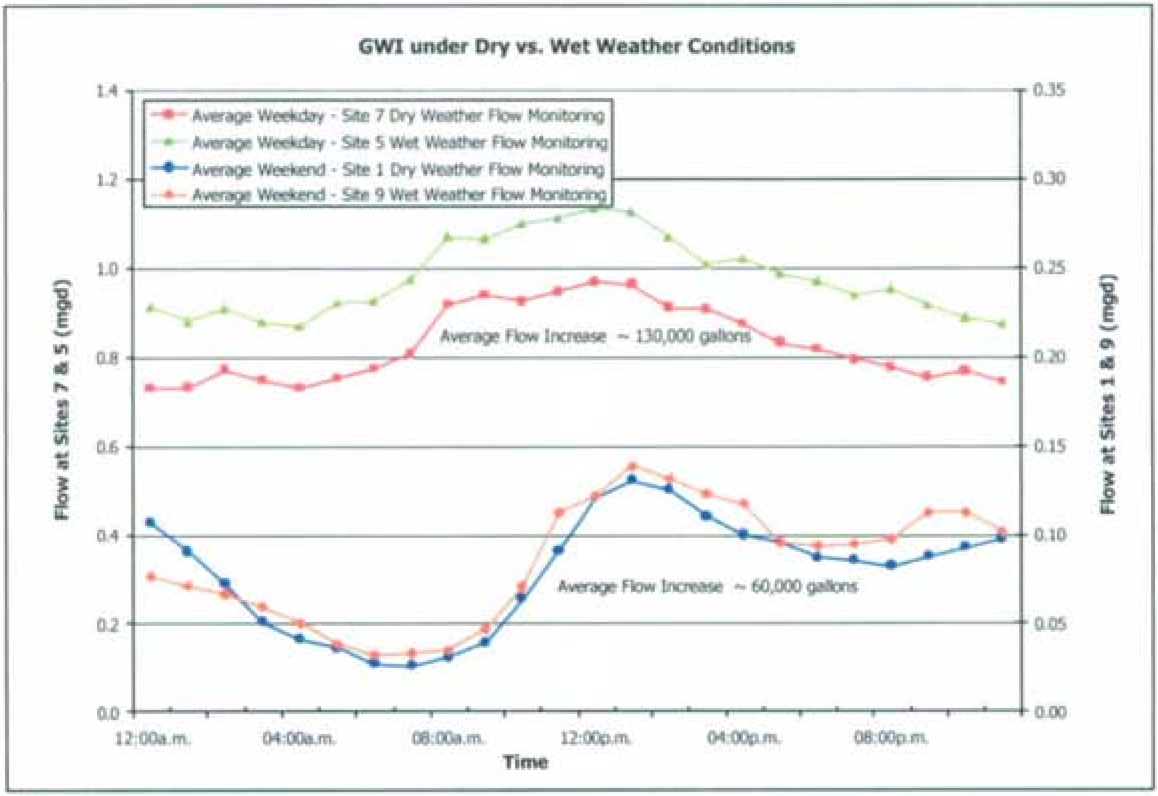
Minimum flow averaged 0.45 mgd at Site 1, which represents approximately 50% of the average flows. A similar ratio was observed during the 1991 wet weather flow monitoring (Carollo Engineers, June 1994) at this site, which reduces the likelihood of a measurement error. High minimum flows could otherwise be due to 1) relatively high residential wastewater flow at night, 2) high groundwater infiltration, and/or 3) industrial activities at night. Since industrial water use records total only 0.08 mgd and residential wastewater production has not yet been calibrated, it was assumed that night flows are due to groundwater infiltration. This assumption will be validated/revised during model calibration.

Estimated GWI rates at sites 2, 5, and 7 shows a significant increase compared to 1984 data. This increase will need to be validated through model calibration before any conclusion can be drawn.
It should be noted that the downturn of the economy significantly affected flows in the industrial park west of I-880. Flow monitoring at Site 8 showed a 40% decrease in the wastewater flows between in July 2001 and Feb-March 2002. This decrease will need to be taken into account when calibrating the model using total downstream flows obtained during 2002 wet weather flow monitoring and base flow production factor established using 2001 dry weather flow monitoring data.

The estimated GWI rates shown in Table 3 were directly input in the hydraulic model, to model GWI under saturated conditions (worse case scenario) in the metered areas. These rates were also extrapolated to areas that were not metered during the wet season, based on similarities in location, groundwater elevation and/or age of sewer as well as GWI rates established during dry weather flow monitoring (see below).

Sites 5 and 9 were monitored as part of both 2001 dry weather and 2002 wet weather flow monitoring programs. Figure 4 compares average flows at these sites under dry and wet weather conditions (respectively, unsaturated and saturated soil conditions).

Figure 4: GWI under Dry vs. Wet Weather Conditions



Notes:

1. Site 7 (dry weather flow monitoring) and Site 5 (wet weather flow monitoring) correspond to manhole 46-1-01.
2. Site 1 (dry weather flow monitoring) and Site 9 (wet weather flow monitoring) correspond to manhole 22-3-05.

The data shows a consistent increase in the hourly flows of 0.13 mgd at Site 5. Unless a new industrial user has started operating 24-hour a day, this difference is due to increased GWI during the wet season. GWI rates at Site 5 are estimated to increase from 400 to 1,100 gpad between dry and wet season. Figure 4 also shows an average increase at Site 9 of 0.06 mgd between dry and wet season. This increase is likely due to increased GWI (Zanker Elementary School, which was not open during dry weather flow monitoring, only accounts for about 5,000 gpd). GWI rates at Site 9 are estimated to increase from 200 to 450 gpad between dry and wet season.

These results were used to estimate GWI under saturated conditions in areas that were monitored during dry weather, but not wet weather (e.g. McCarthy Ranch area).

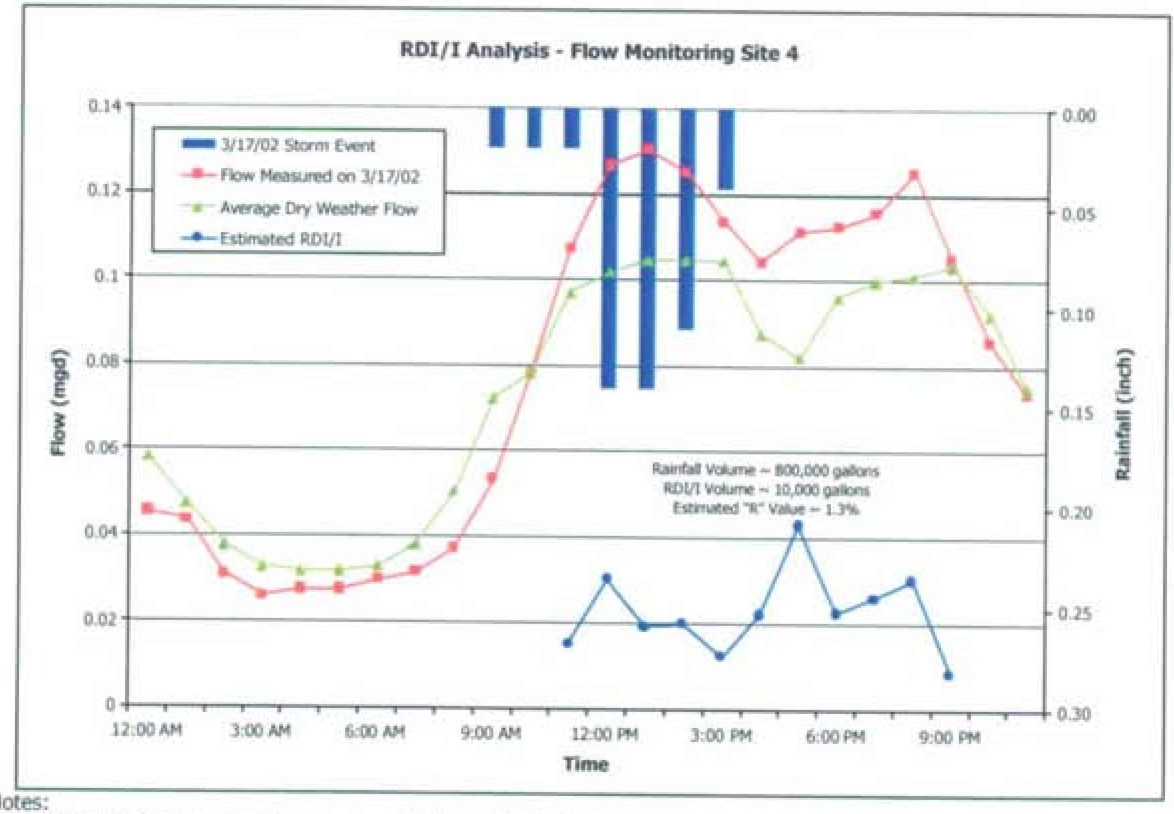
Map 3 shows the estimated GWI rates under saturated conditions that were input in the hydraulic model and will be calibrated using wet weather, total downstream flow data. The calibrated GWI rates (and design GWI rates, if different) will be documented after model calibration in the Master Plan Report.

Rainfall-dependent Infiltration/Inflow

Due to the lack of significant rainfall during the entire monitoring period, the data necessary to estimate RDI/I components under saturated conditions for representative sewer basins could not be collected. RDI/I could only be estimated for Site 4.

Figure 5 summarizes the RDI/I analysis performed for Site 4 for the storm that produced the most significant increase in the wastewater flows (i.e. storm of 03/17/02).

Figure 5: RDI/I Analysis for Site 4



Notes:
1. "R" Value: RDI/I expressed as a percent of the rainfall volume.

Although high I/I was anticipated in Site 4 metered area (sewer inverts below the average groundwater table level; 40- to 50-year-old sewers), the calculated "R" value for the 03/17/02 storm was only around 1-2%. This low value is likely due to low incident rainfall, but could also suggest that RDI/I is not a major issue within the area (although the 1984 Intensive Flow Evaluation study showed that this area was prone to infiltration).

Strip chart readings at the Main PS for November through December 2001 (Winter 2001/02 wettest period as shown in Figure 2) were used to give a sense of the total RDI/I volume over the entire collection system during a more significant rainfall event. The overall RDI/I rate for the City was approximately between 1-2 percent. This low value suggests that overall RDI/I is not a major issue. This would need to be confirmed at the local level with data obtained at the wet weather flow monitoring sites during more significant rain events than those experienced in February - March 2002.

In the absence of wet weather flow monitoring data collected during more significant rain events than those experienced in February - March 2002, the following strategy is recommended to generate RDI/I flows for input into the hydraulic model:

- Input a uniform RDI/I rate into the hydraulic model ("R" value of 2% is suggested);
- Input the following standard shape of hydrograph:
    - Lag-time between beginning of storm and first signs of infiltration: 1 hours,
    - Lag-time between peak of storm hyetograph and peak infiltration: 6 hours,
    - Lag-time between end of storm and end of infiltration: 24 hours;
- Calibrate the RDI/I rate and shape of hydrograph to match the total downstream flows; and,
- Perform a sensitivity analysis of system deficiencies for a range of design RDI/I rates ("R" values of 2%, 5% and 10% are suggested).

The calibrated RDI/I rates (and design RDI/I rates, if different) will be documented after model calibration, in the Master Plan Report.

Hydraulic Model Calibration

Data necessary for the hydraulic model calibration was collected at Sites 1, 10, 11 and 12. The meter at Site 11 was offset after March 10, 2002. This offset was not identified and corrected during the last field inspection. Because of this, data at Site 11 after March 10, 2002, will not be used for calibration purposes. This should not impact the calibration work as enough reliable data was collected over the entire monitoring period. Calibrating the RDI/I component may be difficult as the relative increases in total downstream flows during metered rain events are of the same order of magnitude as the calibration accuracy.

Calibrating the hydraulic model (i.e. running the hydraulic model to validate/calibrate the estimated base flow production, groundwater infiltration and rainfall-dependent components of the wastewater flow, using wet weather, downstream flow data) is actually outside the scope of this TM and will be performed later. The results of the calibration work will be summarized in the Master Plan Report.

Conclusions

The goals of the 2002 wet weather flow monitoring program were to collect the data necessary to perform the following tasks:

- Estimate the GWI rates under saturated soil conditions, associated with specific areas of the system (e.g., old sewers, invert below groundwater table), for input in the hydraulic model;
- Estimate the RDI/I rates, and infiltration hydrograph under saturated soil conditions associated with different sewer basins, for input in the hydraulic model; and,
- Calibrate the dynamic hydraulic model (including validate/calibrate estimated base flow production components derived from the 2001 dry weather flow monitoring program).

Groundwater Infiltration

The estimated GWI rates shown in Table 3 were directly input in the hydraulic model, to model GWI under saturated conditions (worse case scenario) in the metered areas. These rates were extrapolated to areas that were not metered during the wet season, based on similarities in location, groundwater elevation and/or age of sewer as well as GWI rates established during dry weather flow monitoring. Map 3 summarizes the rates that were then input in the hydraulic model. These rates will be calibrated using wet weather, total downstream flow data. The calibrated GWI rates (and design GWI rates, if different) will be documented after model calibration, in the Master Plan Report.

The total GWI volume over the metered area (i.e. approximately 45% of the sewered area) was estimated to be around 1.5 mgd, which constitutes over 15% of the average flow at the main lift station. The total

GWI volume under saturated conditions will also be estimated for the entire sewered area, after model calibration, and documented in the Master Plan Report.

Rainfall-induced Infiltration and Inflow

Due to the lack of significant rainfall during the entire monitoring period, the data necessary to estimate RDI/I components under saturated conditions for representative sewer basins could not be collected. Consequently, the following strategy is recommended to generate RDI/I flows for input into the hydraulic model:

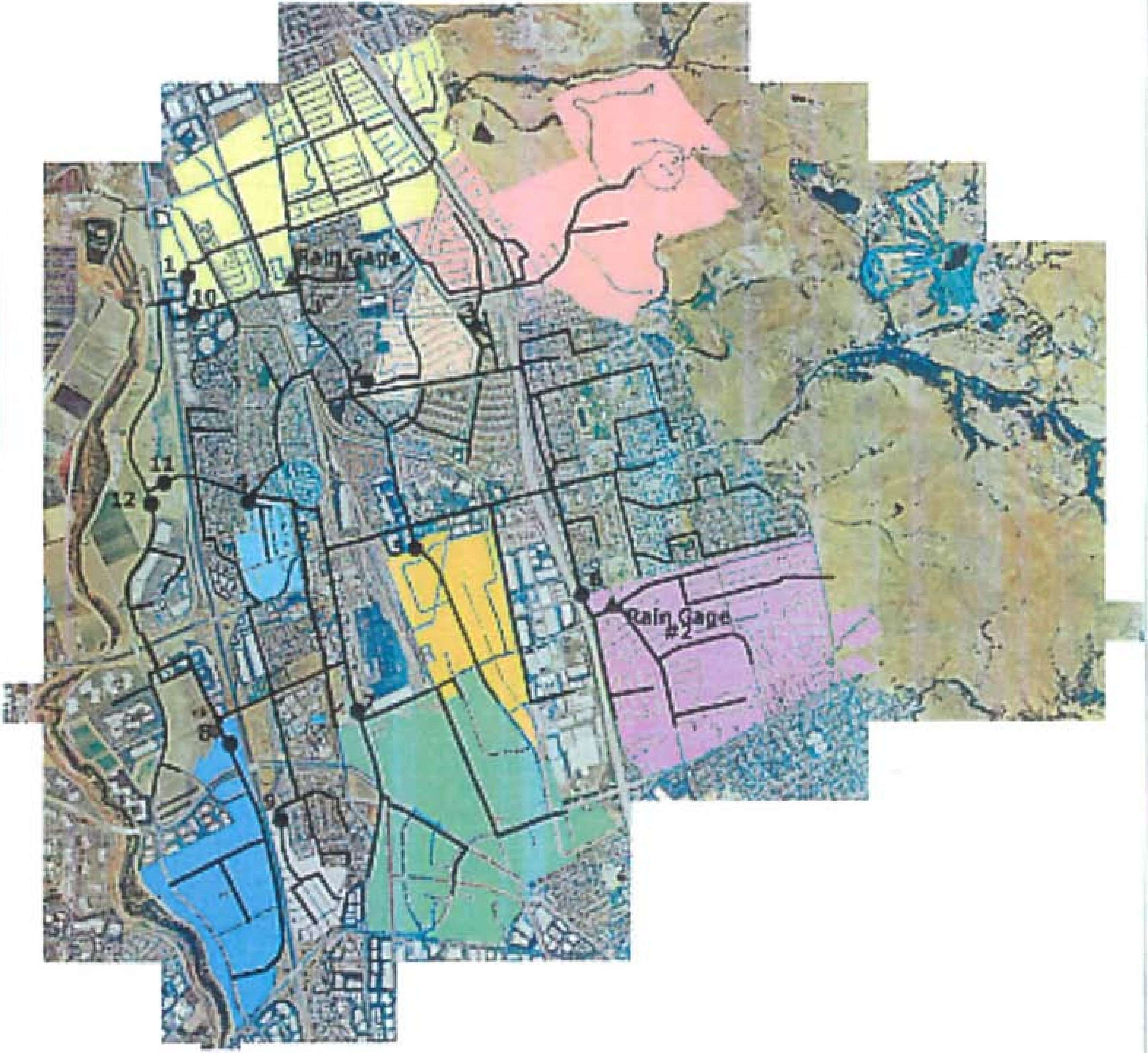
- Input a uniform RDI/I rate into the hydraulic model ("R" value of 2% is suggested);
- Input the following standard shape of hydrograph:
  - Lag-time between beginning of storm and first signs of infiltration: 1 hours,
  - Lag-time between peak of storm hyetograph and peak infiltration: 6 hours,
  - Lag-time between end of storm and end of infiltration: 24 hours;
- Calibrate the RDI/I rate and shape of hydrograph to match the total downstream flows; and,
- Perform a sensitivity analysis of system deficiencies for a range of design RDI/I rates ("R" values of 2%, 5% and 10% are suggested).

The calibrated RDI/I rates (and design RDI/I rates, if different) will be documented after model calibration, in the Master Plan Report.

Hydraulic Model Calibration

Data necessary for the hydraulic model calibration was collected. Calibrating the RDI/I component may be difficult as the relative increases in total downstream flows during metered rain events are of the same order of magnitude as the calibration accuracy. However, no better data is available.

Calibrating the hydraulic model (i.e. running the hydraulic model to validate/calibrate the estimated base flow production, groundwater infiltration and rainfall-dependent components of the wastewater flow, using wet weather, downstream flow data) was outside the scope of this TM and will be performed later.

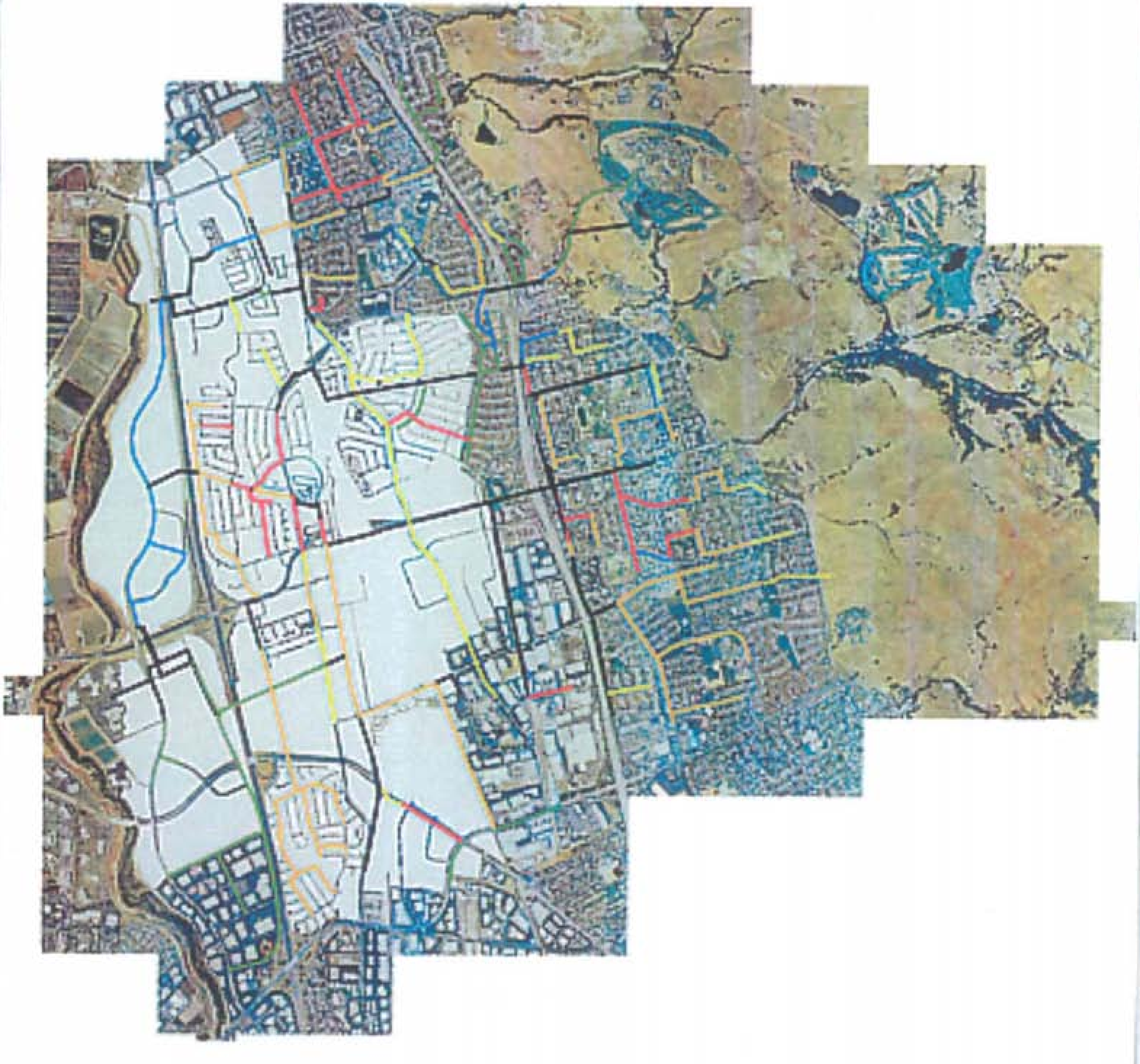


Map 1
Wet Weather
Flow Monitoring Sites

City of Milpitas
Sewer Master Plan

N

0 0.3 0.6 Miles



LEGEND

Age of Sewers

- 1950s
- 1960s
- 1970s
- 1980s
- 1990s
- Unknown

Area of Anticipated GWI

- Invert below Average Groundwater Level

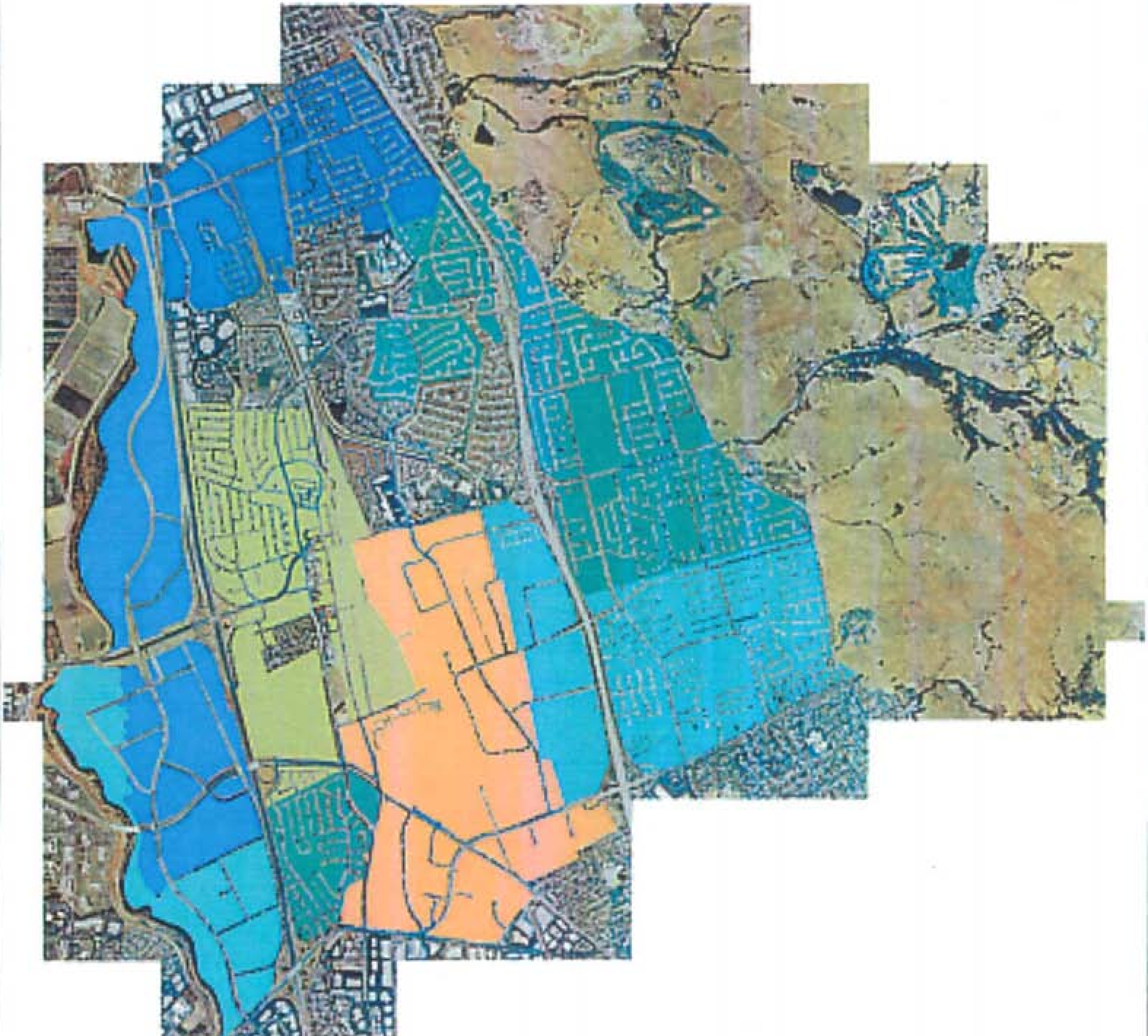
Sources:
1. City of Milpitas
2. Groundwater Infiltration Evaluation (Kennedy/Jenks Consultants, October 199[illegible])

Map 2
Age of Sewers and Area of Anticipated Groundwater Infiltration

City of Milpitas
Sewer Master Plan

N

0 0.3 0.6 Miles



LEGEND

GWI Rates (gpad)

	100
	200
	300
	450
	750
	800
	1100

Notes:
1. GWI rate is set to zero in unexplored areas within City planning area

Map 3
Estimated GWI Rates for Model Calibration

City of Milpitas
Sewer Master Plan

N

0 0.3 0.6 Miles

ATTACHMENT A

Historic Flow Monitoring Information

GWI under Saturated Soil Conditions Calculated in 1984 Intensive Flow Evaluation

Basin	GWI		Basin	GWI	
	(mgd)	(gpad)		(mgd)	(gpad)
A01	0.30	590	B03	0.01	40
A02	0.01	250	B04	0.01	30
A03	0.03	130	B05	0.02	50
A04	0.16	840	B06	0.20	610
A05	0.05	560	B07	0.19	540
A06	0.01	50	B08	0.02	110
A07	0.00	0	B09	0.01	70
A08	0.00	0	B10	0.00	0
A09	0.00	0	C01	0.00	0
B01	0.20	1,250	C02	0.12	550
B02	0.05	240	**Total/Average**	**1.39**	**240**

Notes:
1. Source: Intensive Flow Evaluation (CH2M Hill, November 1984)
2. GWI: groundwater infiltration; mgd: million gallons per day; gpad: gallons per acre per day
3. NA: Not Available

Design RDI/I Flow Rates (Peak Hour) under Saturated Conditions Calculated in 1984 Intensive Flow Evaluation

Basin	Design RDI/I		Basin	Design RDI/I	
	(mgd)	(gpad)		(mgd)	(gpad)
A01	1.56	3,100	B03	0.55	2,000
A02	0.02	600	B04	0.10	300
A03	0.61	2,500	B05	1.15	2,500
A04	0.27	1,400	B06	2.22	6,700
A05	0.67	7,400	B07	0.37	1,100
A06	0.41	1,900	B08	1.39	7,700
A07	0.50	2,400	B09	0.41	3,000
A08	0.91	1,500	B10	0.05	300
A09	0.28	400	C01	0.17	800
B01	0.30	1,900	C02	0.62	2,800
B02	0.19	900	**Total/Average**	**12.73**	**2,200**

Notes:
1. Source: Intensive Flow Evaluation (CH2M Hill, November 1984)
2. RDI/I" rainfall-induced infiltration and inflow; mgd: million gallons per day; gpad: gallons per acre per day; "R" Value: I/I expressed as a percent of the volume of rainfall ("R" × 100 ~ Design I/I ÷ 37,000 gpad)
3. Design RDI/I flows are presented for the 10-year design storm with saturated soil conditions. The design storm is defined as follows:

Return period:	10 years
Duration:	4 hours
Intensity:	0.34 inches per hour
Total volume:	1.36 inches

ATTACHMENT B

Wet Weather Flow Monitoring – Winter 2002

Conducted by E2 Consulting Engineers, Inc.

(See attached CD-Rom)